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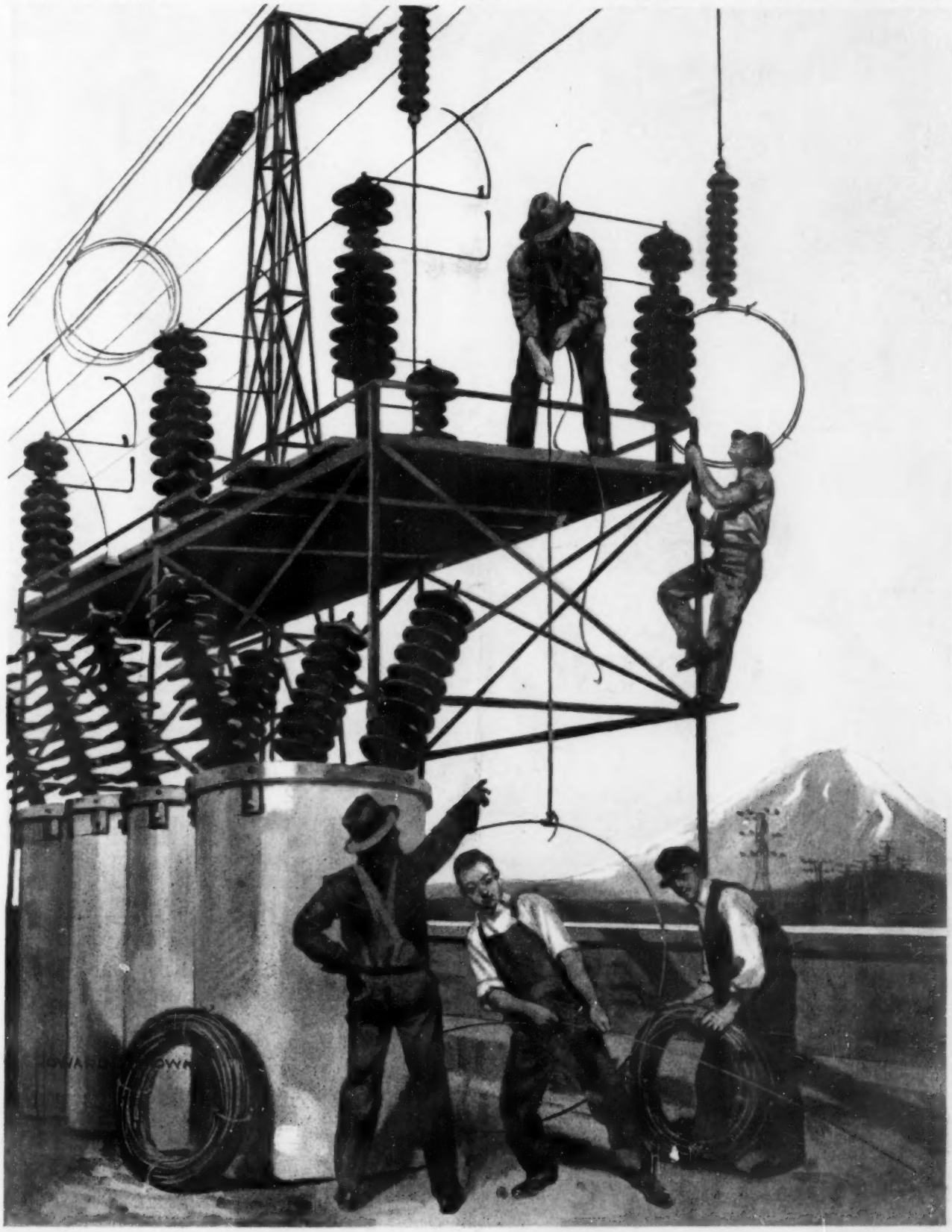
IN THIS ISSUE:

TURNING THE WHEELS OF A CENTURY HENCE
WIRELESS HALF WAY 'ROUND THE WORLD

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



ASSEMBLING THE MAZE OF WIRES AT A STEP-DOWN TRANSFORMER STATION

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June 26, 1920

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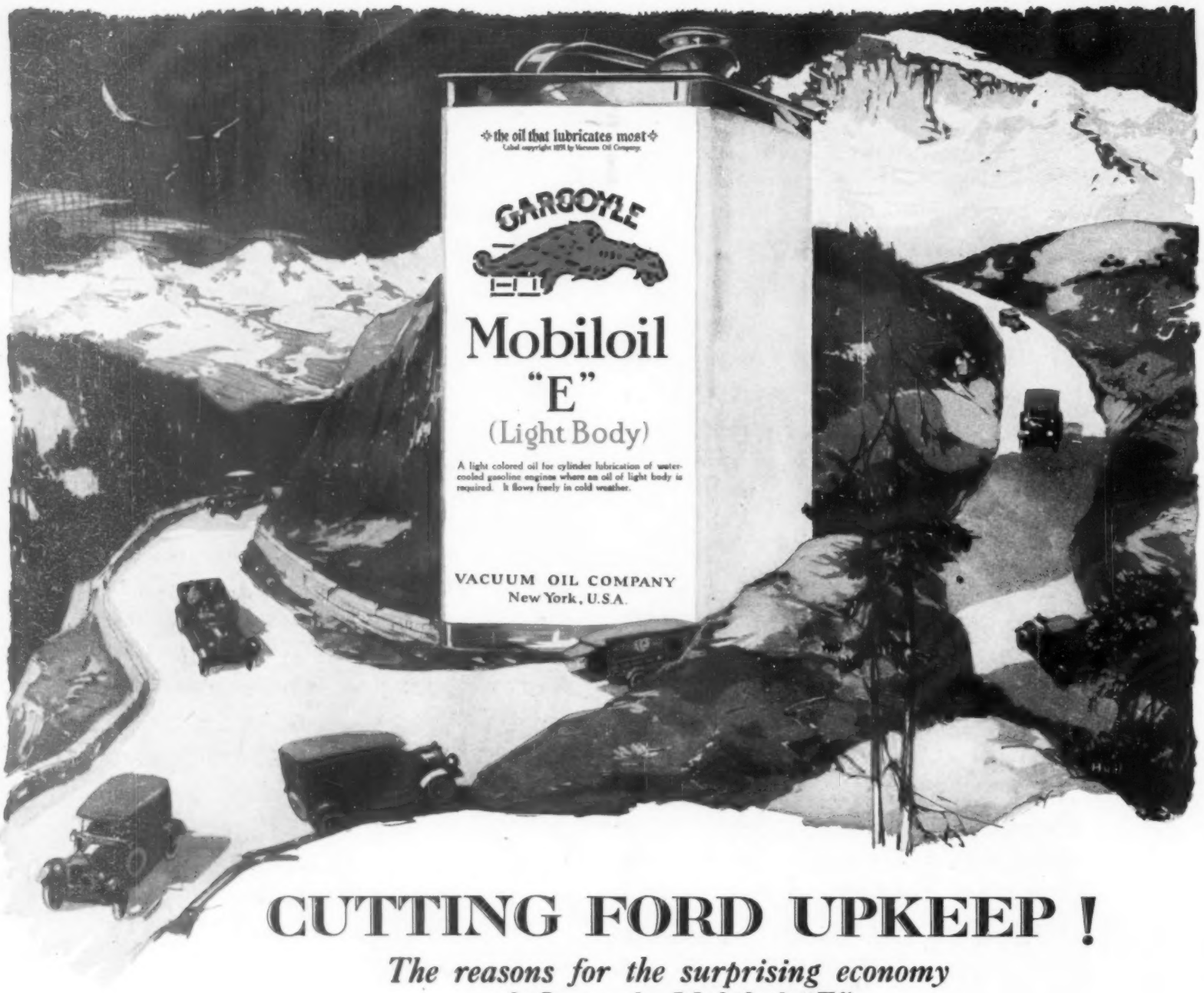
the oil that lubricates most
GARGOYLE
Mobiloil
"E"
(Light Body)
A light colored oil for cylinder lubrication of water-cooled gasoline engines where an oil of light body is required. It flows freely in cold weather.
VACUUM OIL COMPANY
New York, U.S.A.

CUTTING FORD UPKEEP !

The reasons for the surprising economy of Gargoyle Mobiloil "E"

LOW as they are, the upkeep costs of many Ford cars are today far higher than they need be. Operators' enthusiasm over low first cost frequently leads to carelessness over subsequent maintenance costs.

But Ford owners the world over are discovering—

(1) That rapid wear of bearings can be prevented.

(2) That frequent carbon cleanings are not necessary

(3) That frequent overheating should not be tolerated.

Some Drivers' Experiences

A Ford owner in Minnesota reports that during three years use of Gargoyle Mobiloil "E" his engine has not required a single repair.

A Massachusetts owner—also after three years of similar experience — had his engine taken down only to find pistons and bearings "in fine condition."

We could fill page after page with Ford experiences showing astonishing gains in economy and service after changing to Gargoyle Mobiloil "E". We might tell of the Ford owner who climbed Ben Nevis, in Scotland—of severe Ford lubricating problems met by Gargoyle Mobiloil "E" in torrid countries and toward the poles. But after all, these would sum up into one subject—the benefits of scientific Ford lubrication.

The surprising efficiency and economy shown by Gargoyle Mobiloil "E" is due to its ability to meet five mechanical conditions in the Ford engine. These are:

(1) Ford lubricating system.
(2) Ford piston clearance.
(3) Ford ignition system.
(4) Ford bearing design.
(5) Ford clutch and transmission design.

What "body" oil for Fords?

A mistake sometimes made by Ford owners is the use of an oil heavier than Gargoyle Mobiloil "F".

Every one of the five factors mentioned above demands an oil of the body and character of Gargoyle Mobiloil "E". It is readily atomized and distributed by the lubricating system—it gives proper piston ring seal—it reaches all the close fitting bearings—it eliminates the dragging of clutch and transmission bands caused by heavier oils.

In arriving at the recommendation of Gargoyle Mobiloil "E" the Vacuum Oil Company has considered the important factors of Ford design in the light of its many years' experience in scientific lubrication. *The body of Gargoyle Mobiloil "E" is scientifically correct for Ford cars.*

▼

Gargoyle Mobiloil "E" will give you superior *engine results*. If you want superior *engine results* a 5-gallon can of Gargoyle Mobiloil "E" will introduce them to you.

VACUUM OIL COMPANY *Specialists in the manufacture of high-grade lubricants for every class of machinery. Obtainable everywhere in the world.* **NEW YORK, U.S.A.**

Domestic Branches: New York, Boston, Philadelphia, Pittsburgh, Detroit, Chicago, Minneapolis, Indianapolis, Kansas City, Kan., Des Moines.

STEEL is steel and machines are machines.

Yet one forging holds and another fails. One says, "Rely on me" and proves it—the other brings failure and peril when it breaks under strain.

Why the difference?

Men.

The proudest product of the Billings & Spencer Company of Hartford, the First Commercial Drop Forging Plant in America, is men.

Men in executive positions who have descended from the founders of the business—who got from their own fathers the Triangle B ideal.

Men in the shops to whom the crash of the hammers has been music for a quarter of a century. Such a man as, grown too old for active work, begged to be allowed to stay in the shops as a watchman, because the thunder of noise and the bursts of live sparks were part of his life. He stayed.

Men who have grown up and grown old in the Billings & Spencer tradition that "into every forging goes our whole reputation."

Men to whom steel is a living and breathing thing, with human faults or virtues, who could not work if they were not allowed steel worthy of their craftsmanship. Men to whom great machines are as their own fingertips—who constantly plan for better work, to whom the improvement of a single screw is an epoch of accomplishment.

Men who think only of the product—who send out their forgings into the world of industry as a father sends out his sons—giving them the best there is in themselves.

Just men.

And that is the only difference between forgings, the only difference between this tool and that, the only difference between machines.

Men.

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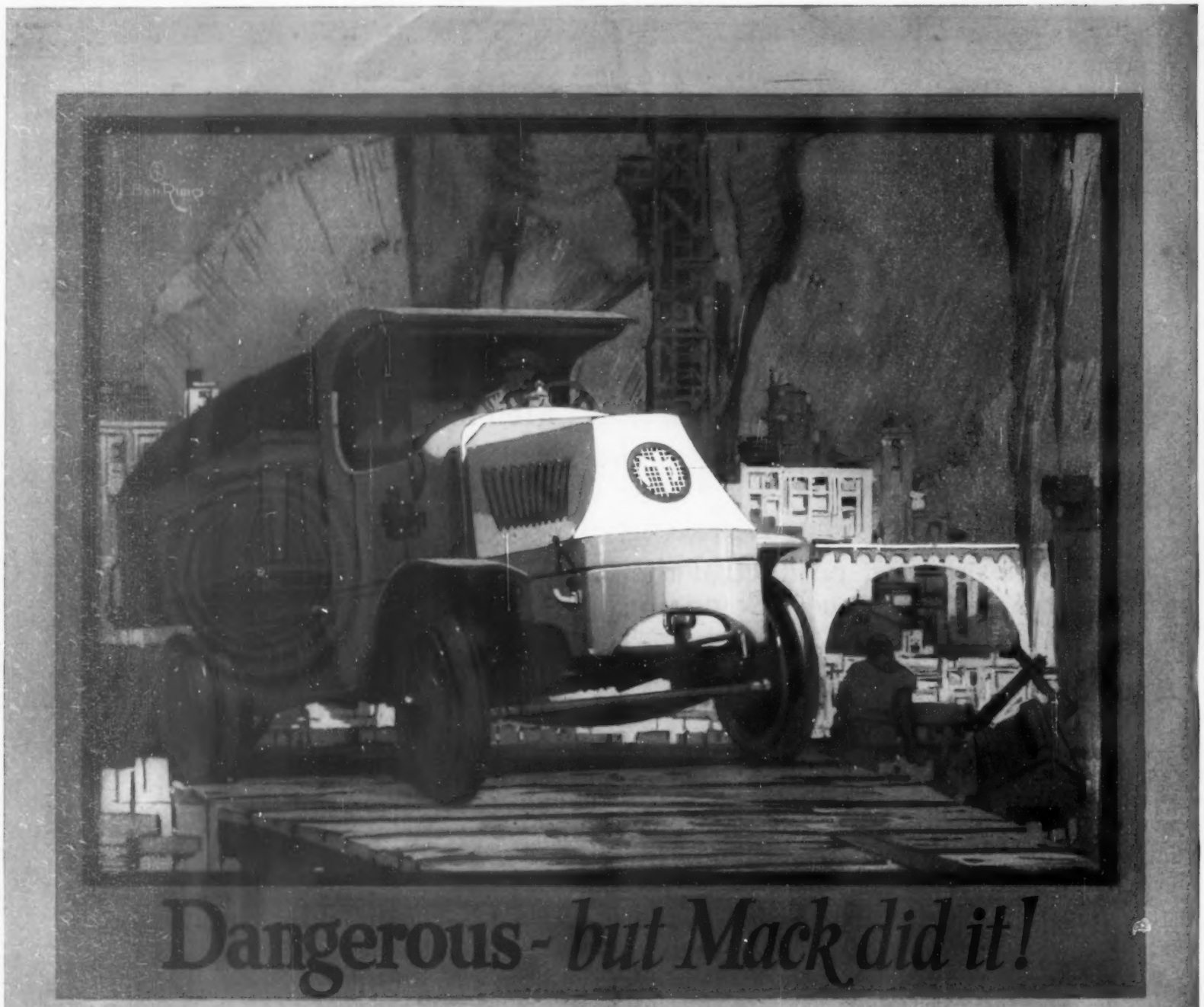

Dangerous - *but Mack did it!*

34 round trips daily, backing its load down a dangerous 15% grade and dumping into a 30 foot excavation, was a braking performance that could not be duplicated by any other truck in the contractor's fleet.

MACK service brakes are fifteen inches in diameter and three inches wide, operating on the driving sprocket. The emergency brakes are twenty inches in diameter and three and a half inches wide, the drums being bolted to every spoke of the rear wheels. Each set is amply air-cooled and hand adjustable.

Mack Engineering features combined with 18 basic *Mack* patents have developed the Motor Truck the world is talking about.

Capacities 1½ to 7½ tons. Tractors to 15 tons.

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INTERNATIONAL MOTOR COMPANY, NEW YORK

Mack TRUCKS

"PERFORMANCE COUNTS"

SEVENTY-SIXTH YEAR

SCIENTIFIC AMERICAN

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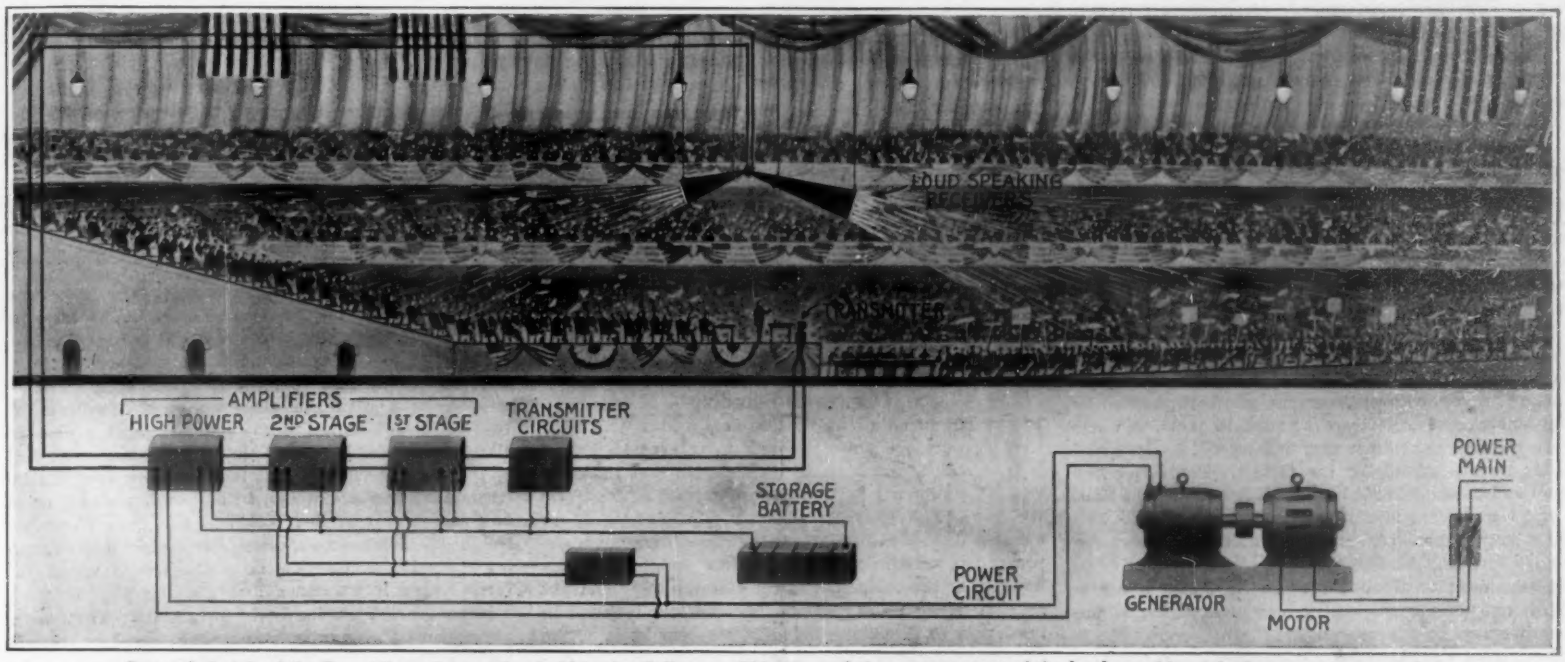

General sketch of the Republican Convention held in the Coliseum, Chicago, and the arrangement of the loud-speaking telephones and accessories

Addressing Thousands without Raising the Voice

By Ralph Howard

FOR the first time in many years the attendance at the National Presidential Conventions is not too large to hear the speaker's voice. Not that the crowds are any less in number or that they are jammed any closer together, but the voice of each speaker is made loud enough for every one to hear by means of a new and remarkable invention, the latest development of the loud-speaking telephone. The long arm of electricity has conveyed the force of falling water miles away to push a thousand heavily-loaded street cars. It has transmitted the stored heat and light of coal into a million homes and factories. It has faithfully carried the faint voice of a child across the continent, so now it wraps its strength around the voice of the orator and gives it power and volume to reach the distant auditor with all its expression and its timbre intact.

Just in time for the Republican Convention, the engineers of the telephone system have successfully completed a voice-magnifying apparatus embodying newly discovered features of telephony, which the inventor of the telephone could not have foreseen. In the Coliseum's vast auditorium, telephone experts were at work for ten days installing the intricate apparatus through which electricity, the master magician, now serves clear and distinct sound to the occupants of the most distant seats. There is little to see of the miracle-working mechanism in the great convention hall. An inconspicuous transmitter of speech is raised up a few feet from the front of the speaker's platform, and overhead are suspended several receivers, being rectangular wooden horns perhaps ten feet long with their open ends pointed toward various parts of the auditorium. The flags and bunting are still the conspicuous eye-catchers. Without seeing how it is done, the audience finds that as far as hearing is concerned, the great crowd has been telescoped by the public address system in close proximity to the speaker's platform. Under the floor and behind the walls of the Coliseum run the wires which lead to and from the speech-magnifying apparatus, itself hidden away in an unseen part of the building.

Although this invention is unlike any of the previous attempts to solve the problem of speech magnification, it is not spectacular in appearance, and, like a telephone plant in general, it accomplishes its great results from behind the scenes. As the modern surgeon can take amazing liberties with the human body to rebuild and revive it, so the telephone engineers have been able to take great liberties with audible speech, transmitting it into electrical waves and building up the force of these without distorting the sounds which finally reach the ear of the listener. Speech electrified in one way can be sent for thousands of miles along a wire. If electrified in another way it can be hurled through ether across continents and oceans. Again electrified in another way it can be discharged from a receiver horn with such power that it will travel through the air as the natural sounds travel, but to a much greater distance and in a manner to dominate other sounds.

The loud-speaking telephone system which has been placed in the Coliseum at Chicago and which it is planned to place in the San Francisco Convention also, has been in process of development for about ten years. The experiments have been numerous and of great scientific interest, but there has also been a romantic side to the work, which was mostly done in the laboratory on one of the busiest and noisest water-front streets in New York. Amidst all the rattle and bang of a thousand teams and motor trucks pounding the stone pavement, teamsters thinking of nothing but their right-of-way were startled to hear a strange voice, apparently close to their ears, deliberately and clearly counting above all the confusion, "one, two, three, four" or reciting some rhyme like "Hickery, dickery, dock, the mouse ran up the clock." Those teamsters could hardly see the horn on the roof of the lofty laboratory building, nor guess that tests were being made which would facilitate the nomination of a presidential candidate. The best the teamsters could do was to wonder how they could hear these tests in spite of the nearest load of heavy angle-iron which was clattering over the rough cobblestone pavement.

On a foggy night a little group of telephone engineers crossed the Hudson River and from the roof of the Pennsylvania Station listened while the same rhythmic counting came weirdly out of the mist. But the test which counted most was the vocalizing, for a vast outdoor audience in the New Jersey Velodrome, of the judge's announcements of the bicycle races.

There have been various demonstrations of earlier apparatus, but beyond the tests necessary to assure complete success, the demonstration at Chicago is unprecedented in the history of the world. The stage is set for the opening of a memorable convention. The speaker addresses the delegates. The sensitive transmitter is ready at the front of the platform above the heads of the correspondents. The speaker does not have to speak into the specially sensitized transmitter, but may walk back and forth at will. The sound of his voice is carried to the amplifying apparatus. This sound has been impressed upon silent electrical waves, which are gradually stepped up by being given greater electrical force. The force of the original wave-carrying current is magnified many thousands of times before it is delivered to the loud-speaking receiver and there converted into sound. The loud-speaking receiver or horn and the speaker himself are perfectly synchronized and the human speech mingles with its electrical counterpart in complete unison. The nearby audience hear the speaker and the loud-speaker as if it were one voice, while the more distant audience hear only the loud-speaker.

During the war the loud-speaking telephone was adapted to several different classes of military service. On battleships such telephones were developed for transmitting orders. On the submarine chasers the loud-speaking system of telephony was extensively used in connection with the radio equipment and in detecting enemy submarines. Doubtless there will be many very valuable uses for the loud-speaking telephone, but at the Republican National Convention, as it day after day brought that tremendous audience into hearing distance of the orators, it again demonstrated the leadership of American invention.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Commercial Airplane Development

NOW that the urgent necessity for military airplanes is past, commercial airplane development takes the field. That this development will be slow, that it will be some time before the commercial airplane is a paying proposition, may be conceded. For the present day airplane is a highly specialized machine, capable of limited use by specialized men.

The steamboat was simply a sailboat carrying its own motive power. The automobile is a vehicle with its power internal, instead of external. Each used the lines of travel of its predecessors, and both profited by the centuries of experience accrued in them. Oceans were charted, navigation was understood, harbors and lights were provided for the former. The latter had more or less suitable roads to operate on from the first.

But the airplane starts in an entirely new field. Little is known about meteorological conditions above the earth's surface. Air lanes are not charted; signals are not provided; until adequate landings, etc., are provided, extended cross-country and night flying is uncertain except by the most expert fliers.

Neglecting the plane for a moment—before commercial aviation is possible, the main lanes of travel must be established, emergency landing fields must be provided, every city must have a large field for landing and starting. These routes must be well marked, and lighted at night; for it is at night that best flying conditions prevail. Furthermore, the system of communication must be such that weather conditions at all points are known. Until this is done, flying will be too uncertain to be profitable. It *will* be done, but not quickly, and commercial aviation will proceed with it.

The flying boat is often suggested as a means of getting around the above conditions. But, unfortunately, the flying boat is exactly what the name implies—half boat, and half airplane, and not quite either. On the water, it is an indifferent craft, difficult to maneuver, and quite unseaworthy. And because of the necessary boat-hull, it is extremely heavy for its weight-carrying capacity. Furthermore it is limited to over-water travel, and to load, unload, handle and maintain, it requires more time and organization than does the land plane.

Considering now the possible trend of plane development, it was stated that the present-day airplane is a highly specialized machine. In the main it is designed for war purposes only. High speed, climb, ability to do acrobatics, are criteria of the smaller machines. Similar characteristics plus carrying capacity are essential in the larger, or bombing type. But neither is at present so designed that commercial equivalents of the military load can be efficiently carried; and all have too high landing speeds.

It is evident that the first change to be made will be in producing a design capable of carrying commercial loads—passengers, express or freight. And this change will doubtless first be successful on the smaller type planes which are at present more nearly standardized. Bodies will be made wider, stowage and passenger space provided, and the wing curve made one of greater lift, permitting slower landing speeds. Then as these prove successful, the multi-engined plane will come into its own. But neither will progress faster than air-lane and landing-field development.

At present the small plane development seems to be toward the monoplane, or the plane-and-a-half type, with few or no struts. These permit more efficient wing actions and reduce parasite resistance, and careful design renders them adequately strong. Because the small plane is today most highly developed and standardized, and because development of small planes is going fastest, it is probable that commercial success will come first to a plane of not more than 50-foot wing span, and having a single engine.

With the development of truly efficient airplane engines, and with an increasingly extended experience in commercial aviation as a basis, the large plane will come into its own. For the success of the multiple-engined plane depends upon these two factors. The large plane of today represents too great and uncertain an investment for pioneer commercial work. And it is certain that no commercial organization is going to tolerate the amount of housing space required by the present day plane.

It is evident, therefore, that improved designs will incorporate some means of folding back the wings along the fuselage. On the monoplane this is easy, simply necessitating a universal joint at the rear spar hinge, a standard front hinge, and snap control and support cable connections. On biplane construction the problem is complicated by stagger and dihedral, as well as the bracing and control wires. But certainly the problem will be solved, so that the housing space required by the plane of the future will compare more favorably with the space required by the fuselage alone.

Our Naval Standing

THE fact that we are the only nation which has continued since the war to enlarge its battleship strength made it inevitable that the question of supremacy of the sea would arise and form the subject of discussion—in other words, that our naval policy should stimulate instead of helping to repress that race in naval armaments to which it was hoped that the extinction of the German navy had put an end. Evidence of this thought and talk is found in an article by Archibald Hurd in a recent issue of the *Illustrated London News*, in which a very striking comparison is made of the strength in capital ships of our own navy and that of the British, when our present program of construction shall have been completed, that is to say, about the year 1924.

Except for the finishing up of a few of the smaller types of vessels, Great Britain has no construction on hand and has no thought of laying down a new program. The same is true of France and Italy. In this country, at the time the article was written, we had eighteen capital ships authorized or under construction, each of which will be larger and more heavily armed than any existing ships in the world. The battleships include the "California" and "Tennessee," of 32,300 tons, mounting eight 16-inch and fourteen 5-inch guns; the four battleships of the "West Virginia" type of 32,600 tons, mounting eight 16-inch and fourteen 5-inch guns; and, lastly, the six battleships of the "Indiana" class, each of 42,300 tons displacement, mounting twelve 16-inch and sixteen 6-inch guns.

In addition to these are the six battle-cruisers of the "Lexington" class. The designs for these huge ships have been greatly modified, the speed having been reduced, but the size increased. The displacement has risen to 43,500 tons, and they are thus the largest capital ships of any kind on paper or afloat. They will carry eight 16-inch and fourteen 5-inch guns.

For the purpose of comparison, Archibald Hurd considers that both battleships and battle-cruisers should be divided into two classes, since the first class, or super-dreadnought, to use a rather common but ambiguous term, are so much more powerful than the earlier dreadnoughts or battleships as to require a separate designation. He considers the same thing to be true of the battle-cruisers. So, basing his comparison on the determination of the British to lay down no new ships for a while, he estimates the relative naval strength of the two leading naval powers will stand in 1924 as follows: In first-class battleships, the British have ten carrying the 15-inch gun, and we shall have ten mounting the 16-inch gun; in second-class battleships, the British have thirteen mounting the 13.5-inch gun, and our navy will have eleven, mounting the 14-inch gun.

In first-class battle-cruisers, the British have three mounting the 15-inch gun, and we shall have six mounting the 16-inch gun. Of second-class battle-cruisers, armed with the 13.5-inch gun, the British have three; we shall have no second-class battle-cruisers. Summing up, we find that by 1924 the British will have thirteen first-class capital ships against sixteen in the American navy, and that they will have sixteen second-class capital ships as against eleven in the United States Navy. As a final consideration, he asks whether, in view of the modifications which are sure to be made, as the records of the war are studied, it would not be better to delay the construction of new ships for two or three years as the British are now doing. The answer to that is that our new battleships and battle-cruisers are supposed to embody the facts of more experience.

Collective Selling in Foreign Markets

COMBINING under the Webb law to meet the intense and highly organized competition for the world's trade of powerful foreign organizations, more than one hundred groups of American manufacturers and sellers filed their papers with the Federal Trade Commission during the first year of the law's operation.

This wholesale availing themselves by American business men of the privileges of the Webb measure demonstrates that this act was based on sound postulates. Before the legislation which relieved combinations for the conduct of foreign trade of the risk of entanglement with the older statutes, American exporters had of course to go it alone. With a concern like the Standard Oil this did not make a great deal of difference, perhaps. But there are few concerns indeed, American or foreign, in any such position or of any such power in their fields as this one. For practically all American exporters our higher manufacturing costs imposed an initial disadvantage which the comparative inexperience and the inability to work together served admirably to perpetuate. The nature of the competition which they were forced to meet is perhaps not everywhere clearly understood. They were dependent almost wholly upon foreign cable and telegraph companies; foreign banks; foreign ships; even in many cases upon foreign selling agents whose interests were better served by selling goods of European origin.

It was just as though a New York dealer trying to establish a business in Chicago were to find all the railroads leading into Chicago prepared to delay his shipments to the utmost, and all the Chicago truckmen eager to lose them or damage them; all the Chicago banks eager to hamper his collections, to falsify his credit reports so that he would sell to the prospective bankrupts and turn down the merchants of standing, to embarrass in every way possible those who had the temerity to buy from him; the Chicago post office and telegraph stations systematically selling to local manufacturers copies of all his communications to his agents and his customers; and his agents themselves for the most part interested in his competitors' lines more actively than in his. Faced with this sort of "competition" American exporters have been at a decisive disadvantage in foreign trade.

Not alone have the most powerful selling organizations in the world worked against our merchants in competitive markets—such organizations as the German electrical and chemical cartels of which we know so much more now than we did in 1914, and the famous Cambrian coal combine of Great Britain. Foreign buyers, too, it turns out, are as closely organized as the sellers; through their powerful organizations they have forced American sellers to compete with each other as well as with their British, French and German rivals—to bid against one another for sales. It is obvious that the only way to meet collective buying in a field largely filled by collective sellers is by collective selling. The eagerness of our sellers to come under the wing of the law which legalizes collective selling in foreign markets is sufficient evidence that this law was needed, and that our merchants are keenly alive to the importance of foreign trade.

Electricity

Another Portable Wireless Set.—The usual outside aerial is eliminated in connection with a wireless set recently developed for general use. This set, which makes use of a loop in place of the usual aerial, is said to have a sending range of from 10 to 12 miles and a receiving range of from 200 to 300 miles under favorable conditions. In the newly-designed detector used in this set a glass dust-proof cylinder keeps the crystal clean and free from vibration.

Electrode Cooling Ring for Electric Furnace.—In order to prevent the ignition of the hot gases escaping from the furnace roof, a manufacturer of electric furnaces has designed a cooling ring for the electrode. The roof portholes are kept cool, the electrode is kept reasonably so, and the gases are cooled down as they leave the furnace, according to the designer. The gases, after passing through the roof porthole around the electrode, pass through a clearance in the cooling ring and into a relatively large chamber. Here they expand and give up considerable heat, which is absorbed by the water in the cooling ring. The process is repeated in a large chamber, and a thin enclosing cover dissipates still more heat as the gases pass out to atmosphere, too cool, says the designer, to ignite.

Austrian Portable Radio Sets.—A recent article in *Elektrotechnik und Maschinenbau* describes a number of war-type radio-telegraphic sets of Austrian manufacture. In one small trench station at 1.5 hp. gasoline motor, belt-connected to an alternating-current machine, supplies the energy for a quenched-spark transmitter. The alternator is provided with a commutator for charging a small storage battery, supplying direct current for vacuum-tubes, but in an emergency the machine may be run as a converter from the battery. A naval spark station of 400 km. (250 miles) radius is illustrated, where direct receiving on a crystal detector is employed on a continuous range of 150 m. to 6,000 m. wave length. Even in airplane stations the spark transmitter was used, but vacuum tubes were employed as detectors and for audio amplification.

Wireless Calling Device.—A new Marconi calling system enables a station equipped with an automatic transmitter key to call up stations within range which are fitted with the corresponding selective receiver relay, even if no operator or watcher is on duty at these stations. The calling-up operation is effected by a powerful bell, which starts ringing at the called stations a few seconds after the key at the calling station has been pressed. It is intended that this bell be regarded as the alarm for such emergency calls as the "S.O.S." and the "T.T.T." by ships. The signal is sent out by means of an automatic transmitter and relay key, which latter closes and opens the ordinary transmitting circuits at exactly the required rates. It is well to bear in mind that the German Telefunken wireless system developed a calling system fully ten years ago which answered about the same purpose.

More About Vacuum Tubes.—In a recent paper before the Physical Society of Great Britain, Dr. W. H. Eccles has the following to say about the mathematical theory of the ionic valve tube: Taking first the "diode" or tube provided with two electrodes (an anode and a heated cathode) he discusses the relation of the current through the tube and the voltage between the anode and the cathode. A characteristic curve is built up showing how, up to the first knee in the curve, the current increases relatively faster than the applied voltage, the current being proportional to the 3/2 power of the voltage; after this it virtually obeys Ohm's law up to the second knee on the curve when the current ceases to grow with increased voltage because all the electrons are carried to the anode. The form of the earlier part of the curve is investigated, and a similar and more extended treatment is given of the "Triode," or three-electrode tube. In this case, when the control electrode is made positive to the filament, the back E. M. F. is reduced by an amount proportional to the voltage of the electrode. This is called the voltage factor of the tube. It is greater than unity, and is sensibly constant throughout the characteristics. Applications of the theory to the determination of output voltages and amplifications are given.

Science

Oceanograph Research in the Mediterranean.—An international conference which met recently in London took steps to organize coöperative researches in the Mediterranean, in which the various countries bordering that sea will take part. A permanent central office of fisheries is to be opened at Monaco, and regular campaigns of fishery investigations will be made every spring and autumn. Four ships will be at the disposal of the office. Coöperative hydrographic surveys will also be carried out. Results of these activities will be published in a bulletin in French, Italian, Spanish and English.

A Research Institute in New Zealand.—Scientific research is the order of the day. The latest research establishment to appear on the horizon is the Cawthorn Institute, for the founding of which the late Thomas Cawthorn, of Nelson, New Zealand, left the sum of £240,000. Its chief work is to be "instruction in the performance of scientific research; such research to be definitely related to the industries of Nelson and of the Dominion," *i.e.*, of New Zealand. A liberal scheme of scholarships and fellowships has been arranged, and an annual "Cawthorn Lecture" has been established. Prof. T. H. Easterfield, of the University of New Zealand, has been appointed director. A site has been secured near Nelson.

A Study of Dental Amalgams.—At the request of the Surgeon General of the Army, the Bureau of Standards has made an extended series of experiments on dental amalgams. There are no definite specifications for these materials. Personal opinion and crude tests have been relied on in the past in grading them. The Bureau has conducted its tests by an interference method and the net results show that many alloys sold as "balanced" or "according to certain principles" in no sense develop the qualities supposed to accompany such products. Permanent specifications for amalgams are to be prepared by the Bureau in coöperation with the Research Institute of the National Dental Association.

A Conference on the History of Science.—Although there has been a considerable revival of interest in the history of science during the last few years, the subject remains something of a by-path, so far as concerns the rank and file of scientific men on the one hand and of historians on the other. Historical papers are, for example, rarely presented at the meetings of the American Association for the Advancement of Science. Special interest therefore attaches to the fact that a conference on the history of science was held in connection with the recent annual meeting, in Cleveland, of the American Historical Association. The papers presented included one by Prof. T. Wingate Todd on Egyptian medicine, one on Peter of Abano (1250-1316?) by Prof. Lynn Thorndike, one on the history of algebra by Prof. L. C. Karpinski, and one on the problem of the history of science in the college curriculum, by Prof. Henry Crew.

The New Secretary of the American Association.—After twenty-two years' service as permanent secretary of the American Association for the Advancement of Science, Dr. L. O. Howard has retired from that office and he has been succeeded by Dr. Burton E. Livingston, the well-known plant physiologist. Dr. Livingston will retain his professorship at Johns Hopkins University. A recent announcement from the Association states that the permanent secretaryship of the A. A. A. S. should be regarded as an office of coördinate importance with the secretaryship of the Smithsonian Institution, the chairmanship of the National Research Council and the presidency of the Carnegie Institution of Washington, and that the incumbent should "hold a position and exert an influence not inferior to that of any scientific man in the United States." To offset the loss which science sustains through the partial withdrawal of men like Howard and Livingston from research in order to attend to the duties of the secretaryship the point is made that, through his work in organizing scientific activities and enlisting popular interest and support, the secretary "might increase by ten per cent the productivity of science in America," and "only a Newton or a Darwin could do so much by his individual researches."

Automobile

Care of Tops.—Mohair tops should be frequently dusted and brushed off. Pantasote tops and curtains are best cleaned with a soft brush dipped in water to which a little ammonia has been added. Afterwards rub dry. Never attempt to clean top and curtains with gasoline or kerosene. Do not fold the top until it has become thoroughly dry, because any moisture remaining in the folds is apt to cause mildew, besides making the top leaky and unsightly with spots. When a car is not used for some time, it is best to open the top, which keeps it well stretched and smooth.

Leaks Through Hood Hinge.—Rain can get through the hinged joint at the top of most "two flap" engine compartment hoods and under certain weather conditions such leakages are a cause of trouble. Recently a motorist stopped his engine while changing a wheel during a heavy rain storm, and when the job was finished the engine refused to start. To lift the engine hood was highly imprudent, as the sheets of rain implied risks of short-circuiting many electrical connections. It finally appeared that leakage of rain through the bonnet hinge had "shorted" all the sparking plugs, and an engine restart was impossible until they had all been dried—no easy job in the open during a rainstorm. Two remedies have occurred to the writer. One is to rivet a wide flap of leather or fiber along one side of the hinged joint so that it will overlap the joint when the bonnet is shut. The other is to fix a long narrow sheet of fiber to the bracket which supports the high-tension cables, thus forming a protecting roof over all the plugs. In the absence of such protection it is wise to keep the engine running during any car stoppages in the open while damp conditions prevail. The temperature of the plugs will then evaporate any moisture that falls upon them.

Removing Stubborn Nut.—While a stubborn stud or sheared bolt is difficult to remove, one can usually unscrew a nut without much trouble, even if it has become more or less rusted in place. A good method to take off a nut that seems to resist being parted from its stud or bolt more than usual is to heat an open spanner or forged end wrench that fits the nut and let it rest against the nut for a few minutes. The heat will sometimes expand the nut without producing corresponding expansion of the bolt and it may be unscrewed. The spanner or end wrench may be heated in a blow lamp flame, and while this kink is very old it is not generally known. One should not heat a hardened wrench or an adjustable member as it may be rendered unfit for use. The blow lamp flame should not be applied to the nut direct because the bolt will be heated and will expand as well as the nut. Kerosene may be poured around the threads with good results, especially if the nut has rusted in place. Several alternate heatings and applications of kerosene oil may be needed before the nut is loosened and if it still resists, a light tapping with a hammer on all the facets while it is hot may assist in having it become looser on the threads.

Piston Wear.—If an engine has been dismantled it is very easy to examine the pistons for deterioration. While it is important that the piston be a good fit in the cylinder it is mainly upon the piston rings that compression depends. The piston should fit the cylinder with but little looseness, the usual practice being to have the piston about .001-inch smaller than the bore for each inch of piston diameter at the point where the least heat is present or at the bottom of the piston. It is necessary to allow more than this at the top of the piston owing to its expansion due to the direct heat of the explosion. The clearance is usually graduated and a piston that would be .005-inch smaller than the cylinder bore at the bottom would be about .0065-inch at the middle and .0075-inch at the top. If much more play than this is evidenced the piston will "slap" in the cylinder and the cylinder and piston will be worn at the ends more than in the center. Pistons sometimes warp out of shape and are not truly cylindrical. This results in the high spots rubbing on the cylinder while the low spots will be blackened where a certain amount of gas has leaked but aluminum alloy pistons require from 1½ times to twice the clearance given cast iron pistons, depending on the type of engine to which they are fitted.

Wireless Half Way 'Round the World

The Most Powerful Radio Station, Built at Bordeaux by the United States and Sold to France

By John W. Kean

THE Lafayette Radio Station, situated eleven miles southwest of Bordeaux, France, the most powerful radio station in the world, has just been completed by the United States Navy and turned over to the French Government. A brief history and a description of this queen bee among the radio buzzers will be of especial interest to all radio men and engineers.

The erection of a super high-powered radio station in Europe was the result of a decision made by a military committee called by the Navy Department, which met at New London, Conn., October 4, 1917, and constituted part of a general program adopted for the improvement of transatlantic radio facilities. It was felt a substantial transatlantic radio service was needed in the event that enemy depredations might destroy or impair communications by cable.

After several preliminary discussions it was agreed that the French Government would furnish a suitable site in France, properly protected, and would erect and furnish buildings, foundations, a water supply and power facilities. The Navy Department agreed to design the plant supply and erect the towers and to install equipment in complete operating condition.

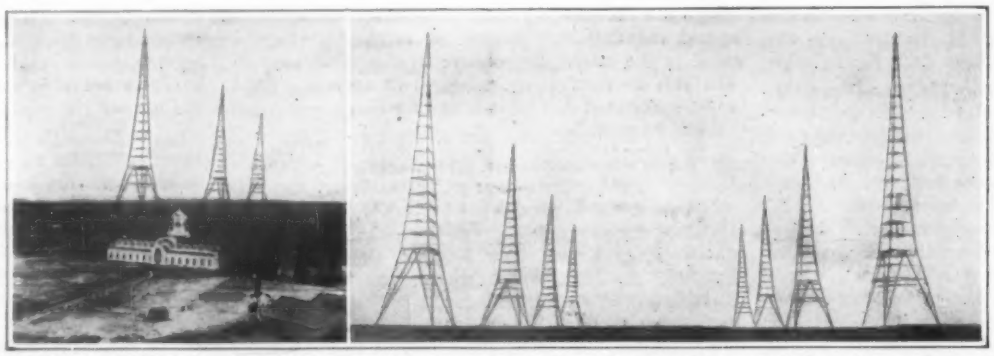
In view of the small size and inadequacy of the existing European stations (Eiffel Tower, Lyons, Nantes and Rome), it was realized that the new station would have to carry an immense volume of traffic in the event that the entire communication burden should be thrown on the radio service; so it was decided to design a plant larger than any in existence.

Signals from European stations were studied, and it was found that even a station as powerful as Nauen (which had been greatly enlarged by Germany during the war) would not be able to give proper service during periods of the day when fading and static combined to produce the most unfavorable conditions.

Alternator equipment for producing radio high frequency currents had not been satisfactorily developed in this country at the time the design of the plant was undertaken and the selection of apparatus narrowed down to the only type which had been demonstrated as entirely successful, namely, the Poulsen arc. The Navy was well informed regarding transmitter types, and a contract was placed with a responsible concern for the radio equipment which was to be rated at an antenna current of 550 amperes with an antenna effective height of approximately 600 feet. This design involved an arc converter and power machinery of a capacity between 1,000 and 1,200 kilowatts. The apparatus was to be furnished in duplicate throughout to avoid any possibility of failure.

While these arrangements were being made the Bureau of Yards and Docks completed designs for an 820-foot three-legged self-supporting steel tower similar in type to the Eiffel tower. The Eiffel tower, however, weighs about 2,700 tons while each Lafayette tower weighs only 550 tons.

In fact the Lafayette towers, eight in number, are the real engineering marvel of the plant. Their three legs rest on large circular concrete platforms which in turn rest upon a series of concrete "feet" placed upon planks sunk deeply into the ground. The sturdy towers are quite capable of carrying elevators and the French have already considered their installation.



Bird's-eye view of the building and another view of the tall steel towers that support the antenna wires

Because of the difficulty of carrying on work overseas by contract, it became necessary to organize a military detachment to erect the station, particularly as the French Government was desirous of carrying on all such work under a military establishment. Through the coöperation of the Bureau of Navigation,

Of all the millions of dollars' worth of equipment and construction work which the United States had on hand and under way in France when the war went dead on our hands, much was of necessity wasted. Here is the story of something that was not scrapped—the great radio station at Bordeaux which, half-finished at the time of the armistice, was completed for the sole purpose of saving the labor that had gone into it, thoroughly tuned up, and sold to France.—THE EDITOR.

Navy Department, a special recruiting party was organized and a detachment containing nearly 600 steel workers, bridgemen, electricians, and all others required (cooks, yeomen, etc.), was sent to the selected site in the spring and summer of 1918, and began work under the supervision of the Bureau of Steam Engineering, Navy Department.

In order to cope with the transportation problem, special officers were stationed at Philadelphia and at Bordeaux to personally supervise shipments. The duplicate radio equipment parts were forwarded on separate vessels to avoid possible loss by submarining, and it is to the credit of the transport service that no material was lost.

Practically all the tower steel and radio equipment was on the station site in September, 1918, an incredibly short time after the inception of the project, together with a complete erection crew and camp. At this date, however, the French had not yet started on the radio buildings or power supply and were just commencing on the tower foundations. The detachment, therefore, had to erect a temporary power-transmission line and furnish a water and drainage system. The officer in charge urged more rapid progress on the part of the French authorities regarding their portion of the work, with the result that several towers were partly under way on the date of the armistice, although nothing could be done toward installing the radio equipment. At this time the rainy season in western France commenced and all progress ceased.

The withdrawal of our military forces from Europe early in 1919 made it necessary to disband nearly the entire detachment, the members of which were returned to the United States. The skeleton of an organization was retained at the radio station, however, and an agreement was finally consummated with the French Government whereby the Republic of France contracted to purchase the Lafayette station on condition that the Navy would complete it. Work again proceeded, therefore, in June, 1919, the tower erection being taken up by an American contractor, and the remaining work undertaken by the Navy, utilizing labor from the New York Navy Yard and elsewhere.

The incoming power supply is 3-phase alternating current of 11,000 volts and 50 cycles frequency. The 1,000 kilowatt, 1,200-volt direct-current generators are driven by synchronous motors with direct-connected exciters for both motors and generators. Special 20-kilowatt direct-current motor-generator sets are provided to excite special field-windings on the arc converters, designed to enable accurate adjustments of the field flux density to be made.

These windings are arranged so as either to assist or to oppose the effect of the usual series windings, which also exist.

The antenna system is of an extent far exceeding that of any existing radio system. The eight 820-foot towers are arranged in two rows of four each. The rows are spaced 1,320 feet apart, and the towers in each row are 1,320 feet apart, making a plot approximately a mile long, a quarter of a mile wide, and containing 5,227,200 square feet.

The power house is located in the center at one end of the aisle formed by the two tower rows. Triatics stretching across this aisle between pairs of towers support the longitudinal antenna wires, which are of number three silicon bronze cable.

A special problem arose in connection with the insulation of this antenna because of the extremely high mechanical loads which the triatics are required to carry, but a special porcelain tubular insulator was eventually developed having

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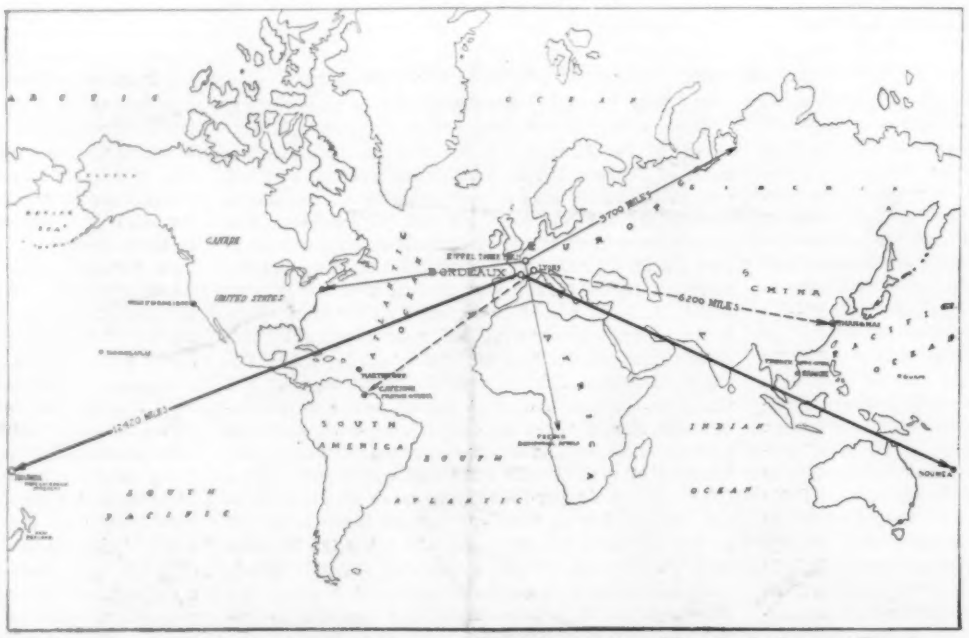
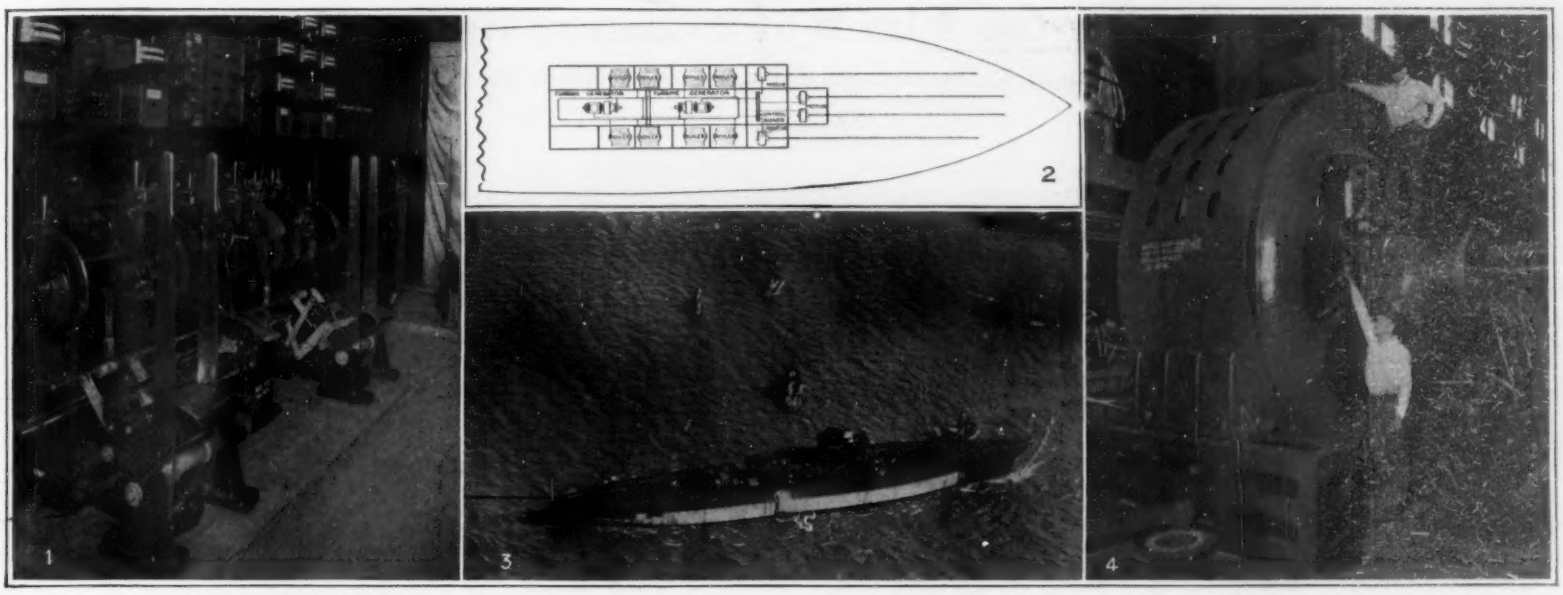


Map of the world showing how the Lafayette radio station can "speak" to the farthermost French colonies on the other side of the globe



1.—Port side control instruments. 2.—Layout of electric-drive machinery. 3.—Looking down on the "Maryland" from above. 4.—One of the propeller motors.

Some features of electrically propelled superdreadnought "Maryland"

More Miles to the Gallon of "Gas"

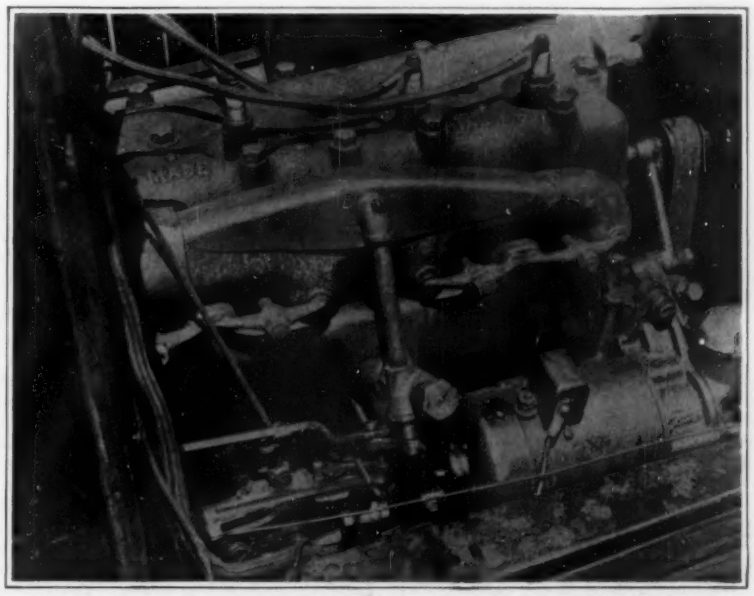
ONE of the remedies for the fuel situation with which automobile users are confronted consists in getting more miles out of the same quantity of the same old gasoline. On the market today are found a wide variety of devices which can with more or less ease be attached to any make of car, and which in one way or another attempt to improve upon the normal efficiency of combustion. Better heating, better supply of air, better regulation of the mixture, better coöperation between the carburetor and the engine, are among the things which these devices try to effect.

Among those gasoline savers with recorded results to back their claims must now be included the one developed after seven years of effort by Dennis J. Pledger of Memphis. An official test of this device was recently run off on the Concourse, New York's famous automobile driveway, under the watchful eyes of six judges whose number included automotive engineers of note and editors of automobile papers and of automobile sections in daily papers. The means of the test was a specimen of the common or garden variety of automobile, flivver, tin lizzie, or, in the non-committal language of the severely upright reporter, "small car" manufactured by Mr. Henry Ford of Detroit. The vehicle in question was a second hand touring car of the vintage of 1919; it was not groomed for the test in any manner, but was run in precisely its condition when captured. Without the appliance it made the usual fair every-day average for a Ford, some 16 miles per gallon. Then the test began at 6:15 P. M. on a thoroughly rainy day, with road conditions anything but ideal. With the Pledger apparatus installed, the tank was filled with a carefully measured ten gallons of "gas" from a nearby garage, which was carefully tested to insure that it was not of unusually good or unusually poor grade—just the sort of gas that you get for your thirty-three cents, more or less, at the ordinary roadside garage. The tank was solemnly sealed, and the car took to the road. For eighteen hours it navigated back and forth on the Concourse, always with one and often with several of the judges riding with the driver. When the engine rolled over and went dead of starvation, the speedometer showed a run of 354.2 miles. It was claimed that the front axle was in need of repairs and gave considerable trouble during the first part of the run, finally having to be adjusted; and that this cut down the showing somewhat. But 35.4 miles per gallon of gas does not require any apology.

As further evidence that Mr. Pledger's contraption will do what it is intended to do, its performance on a New York City Police Department Ford car is cited. It was installed on this car as a result of the Concourse test. The car in question is one that has a good deal of fairly heavy work to do, that is in operation from eight to ten hours daily, and that is shown by the records to have been averaging eight miles per gallon. With the gasoline saver it was operated for several weeks at an average of fifteen miles per gallon. Similar performances have been obtained by numerous other large users of Ford cars and trucks. The demonstrations so far have been confined to cars of the "flivver" persuasion for the simple reason that this is the market which Mr. Pledger and his associates are at present seeking. Not until the results of equipping Ford cars commercially with the new device have justified expansion will it be made for other models.

Mr. Pledger's attachment does its work, after the carburetor has completed its function, by introducing heated air into the intake manifold through a special valve. This heated air is obtained from a brass heater attached over the exhaust manifold. It is fed to the engine at the same time as the gas, and at the various speeds of the engine, causing the flow of a better mixture into the combustion chamber, and therefore causing a better combustion, which overcomes the refrigeration and condensation that take place under the old system after the gas has left the carburetor. It does not make the car harder or easier to crank, nor does it increase the speed—it just saves gasoline and gives a smoother-running engine.

Of course any scheme that results in better combustion will help to eliminate the carbon bugaboo, and the Pledger apparatus is no exception. With it installed, one drives his flivver with a foot accelerator, just as with other cars, leaving both hands free for steering and the signal horn. The throttle lever on the steering post is used, as with the large cars, only at the start.



Gas-saving attachment applied to Ford car used in the official New York test. Note brass heater over exhaust manifold and valve into intake manifold

"Maryland"—Our First 16-Inch-Gun Battleship

THE superdreadnought "Maryland" now completing at Newport News, Va., is the fourth electrically propelled battleship of the United States Navy and sister ship of the "California," which is being put into commission at the Mare Island Navy Yard, San Francisco. She is also the first United States ship to mount the new 16-inch gun of which she carries eight in four turrets.

Like her prototype, the "New Mexico," pioneer electric warship of the world, the "Maryland" is electrical throughout.

Her propulsion equipment was designed and manufactured in the shops of the General Electric Company at Schenectady, N. Y., a city, which because of its pioneer work in electric propulsion has, in a sense, come to be known as the birthplace of electric drive.

Four huge electric motors 12 feet in diameter weighing 62 tons and producing 7,000 horse-power each, revolve the great propellers. The current is obtained from two turbo-generator units driven by steam from nine oil-heated boilers placed in three separate compartments of the ship. Approximately 28,000 hp. is thus available for propulsion purposes or enough to supply power to a city of 100,000 population.

Steam from the boilers under pressure of 250 lbs. to the square inch expands into a Curtis turbine and revolves the turbine blades at high speed. This turbine is directly connected to a generator which produces electric current. Through copper cables this current is then led to a control board where it is measured and passed on to the motors which drive the propellers of the vessel.

A portion of the steam produced in the ship's boilers is diverted to six auxiliary turbo-generator sets which create additional energy for the operation of many other electric features of interest.

These auxiliary generating units for instance will supply the vessel's lighting, operate fans and blowers, run the electric bakery, drive the machine tools used in the foundry, carpenter shop and machine shop, operate the electric laundry equipment, assist in loading the big guns, raise and lower the life boats by means of boat cranes and hoist and lower the ship's great anchors.

Electricity will also be used in the refrigerating room which by means of motor-driven pumps, will produce many pounds of ice a day. Electrically-operated pumps will distill gallons of fresh water from the salt waves for the use of the crew and to furnish the boilers with fresh water.

Among other auxiliary uses of electricity on the "Maryland" may be mentioned searchlights, ammunition hoists, electric cooking utensils, telephones and intercommunication systems, gyroscopic compasses, steering gear apparatus (the ship will be steered electrically), motors

(Continued on page 712)

Turning the Wheels of a Century Hence—I

What We May Expect to Do, and What We May Not, When the Fuel Is Exhausted

By C. H. Claudy

THE essential difference, economically considered, between a tribe of savages and a tribe of Caucasians is that the latter supplement the strength of their arms and legs from sources drawn from nature. The savage lives in a hut, the size of which is limited by his strength to lift and carry logs, poles and grass, and his powers of raising small weights. His horizon is limited by his ability to travel on foot or at best on horseback, his accessories and utensils circumscribed by his ability to fashion with his hands or the rudest of tools. His weapons are no more powerful than the strength of his arms, multiplied by temporary storage of that strength and its sudden release in the case of the bow or the sling shot.

The civilized tribe raises its huge buildings by the use of steam power. It travels by steam or electricity or the chemical power of gasoline or oil. Its weapons are those of gunpowder and the high explosive family, its horizon is the world itself. On land, under land, on the water, under the water and lately high in the air, man travels at will because he has power far in excess of that inherent in his slender body.

All this is so much a commonplace, so trite, and so much a matter of every day experience, that we are accustomed to give no heed to it whatever. We grew from a small world to a great one because power sources became available to our knowledge, and we think, if we think at all, that what has been in the past must continue to be, only perhaps to a greater degree, in the future.

But let us consider for a moment and see whether this is necessarily so. To do this intelligently it will be necessary to define just what "power" is as applied to our uses, and incidentally to this series. It will not do to limit it in terms of "extra force" which a man may use. The savage with his bow throws an arrow further and harder than his unaided hand can encompass it, but he employs no "extra force" to do so; he merely makes useful in a small instant of time the force of his arms, torso and legs, which has been expended in bending a rod of wood and stretching a string through a greater interval of time. Similarly, the man who moves a ton weight of stone with a crow-bar has no "extra force"; he merely makes use of the equation of power and time, which is satisfied if a unit of power does a unit of work in a unit of time, or a unit of power does two units of work in two units of time, or a unit of power does ten units of work in ten units of time. As "time" can also be translated "distance" we have a man who can move a huge unit of stone one unit of distance in ten units of time, or one-tenth of one unit of distance in one unit of time, in either case using one unit of force, multiplied in power and divided in distance exerted, by the lever.

So that power must be considered as something else than artificial aids to doing work with muscles.

"Power" as we use the term here, must be considered as making available a force entirely *outside* of the user. The builders of the pyramids had no "power" as we understand the term, though they may have had an army of a hundred thousand men to pull and haul. Cleopatra's Obelisk was cut and raised by hand but "power" brought it to New York and "power" there erected it.

"Why, of course," says some reader, "power is steam or electricity or gasoline or . . .or . . ." Yes? And what comes after the "or"?

There are not so many sources of power available, when we come to catalog them. Neither electricity nor steam, as we produce them commercially can be called a "source" of power since both are but the transformed power of the heat which we get from coal, or oil, or burning wood. The main, the greatest source of power we have, at the present day, is found in our fuels, and whether we make this power useful as mechanical movement with a steam engine, or as electric impulses, through an electric generator run by a steam engine, or through the burning of a fuel directly in an internal combustion engine, we are but using heat long ago stored for us by Nature in those prehistoric days when the coal beds were being formed and the oil content of the earth was being hidden in the sands and rocks and shales, there to rest for untold thousands of years until the thinking animal should seek them out.

We have other powers constantly made manifest about us, and to some small, almost minute degree, we have tapped these power streams—largely experimentally, often as a curiosity, sometimes only as an economy. No man who has ever been in a tornado but knows that it is powerful. We have used the power of the winds, which is a combination of the power of gravity and the power of the heat of the sun and the power of the revolution of the earth, to draw our ships over the sea; and we use wind power in small windmills. But there we stop, with a total utilization of a fraction of the available wind power so small it could hardly be expressed by a decimal point and a string of ciphers extending across the page, ending with the figure one.

We have the power of the sun's heat always manifest about us, but we use it not. True, we have made solar engines, which collect the beneficent heat of the sun and focus it on a small boiler, and we have run an engine or two so. But sunlight fluctuates, and the expense, compared with a steam engine or an oil engine, is great, and so we neglect the, literally, millions of horse-power poured down upon us daily.

We have the power of the tides—the great force of the moon's attraction for the earth and the earth's attraction for the moon, which moves huge bodies of water twice every twenty-four hours. Enough power is going to waste in the tides to turn every wheel upon the earth, to run every train, to move every automobile, every flying machine—aye, not only to move all that exist but all that may ever exist. But we don't use it. Tide motors are expensive to install, and, so far, require peculiar conditions of terrain to enable them to be used economically. Yet the fact remains that nature is moving billions of tons of weight, regularly, twice a day, and charging us nothing for it. That we don't use this power may some day, to a more civilized race than we, appear as pitiful as do the struggles of our forebears who used sweeps and sails where we use steam, who traveled only by beast of burden where we wing our steel horses with coal or gasoline and make the modern Pegasus to fly literally through the air.

There is an untold wealth of power in the earth's revolution about its axis; Mr. Sperry has made it useful to teach a gyroscopic compass to point to the north. No other use for it is known. Whether indeed, it would be wise to use it, even if we could—whether its use might not slow up the revolution and add to the length of a day—is a question which need not be discussed here. The bare fact is not only that we don't use the revolving power of the earth but that we don't know how to, any more than a fly on the rim of a flywheel can use the power in the wheel to help himself.

There is a vast region of unexplored power in the heat of the earth. What the earth may be like inside is but a guess of the geologist, and one man's guess is as good as another's. That there is heat there we know—*vide* hot springs, volcanoes, earthquakes and similar manifestations. But, save in one or two instances where it is used as a curiosity or to heat a house or warm the water for the boiler of a steam engine, it goes begging.

The available electricity of the world we live in has never even been guessed. The doctrine of the conservation of energy tells us that we never "make" power; we only change its form. Therefore, if we draw electricity from the brushes of a dynamo, we are but changing the form of a power already existing. How much there is, and how available it may some day be, we only pretend to think we can guess. But in spite of man's boast that he has "harnessed the lightning" he has really done nothing of the sort, as is proved every now and then when a lightning bolt gets playful. We know that electricity and magnetism are but different manifestations of the same power; we know the earth is a great magnet; we know that there are tremendous electrical disturbances constantly being effected in both earth and air; but we use them not, except to point a mariner's compass and as a nail on which to hang curses when "static" interferes with our puny wireless.

And then there is the power of gravity—a hindrance, not a help. We fight it when we erect a building. We curse it when we go up in airplanes. We have to consider it when we build railroads and not irk it much more than two per cent in our grades. It was not the height of mountain ranges which prevented tribes from amalgamating and kept nations separated; it was the power of gravity which made the mountains difficult to cross. It is gravity which limits our airplanes as to speed and power and "ceiling," and it is gravity which says "no" when we try to go faster or farther in any direction.

But gravity is one of the natural forces which (in conjunction with the heat of the sun) we can use. We can use it when it pulls a stream from a high level to a low one. Water power, so called—the power of gravity actually—which would be milk or molasses or oil power if milk or molasses or oil had happened to be the universal fluid—is as old as the first beginnings of civilization. The rice fields of primitive countries today are often watered with a water wheel, and no man may say when it was first invented.

But our kinship with our ancient brethren is far too close. True, we use a Pelton or a reaction wheel where he used a simple gravity flow; we transform our water power to electricity, that we may transport our power where he had to use it to grind his corn where the steam happened to have a fall—but he and we both have but scratched the surface of this unmined source of power, of which more in a later paper.

Let us go back a moment and inquire *why* we do not use sun power, wind power, wave power, tide power, earth power, earth heat, and why we still mine coal painfully, dig oil with difficulty and insist that our civilization shall march on the premise that nature's stored heat is our only way of getting "extra force."

First, of course, is the undoubted fact that everything from water to a man follows the path of least resistance—goes the easiest way. It has been easier to mine coal and dig for oil than to utilize other sources of power. Nature stored this power for us, and so we use it, for Nature's secret of storage of power is one she hasn't parted with. We cannot store power, we who do so much, save in an occasional instance and always inefficiently. When we combine saltpeter, charcoal and sulfur we, in a way, store power, against the time we explode our gunpowder. When we "charge" a storage battery we produce a chemical change which rechanges on demand and gives forth a part of the power we thus "stored." We can build a dam and store water in it, and then draw the water off, thus in a way storing the power of gravity. But we cannot store compressed steam for any length of time, nor flow electricity behind a dam as we flow water, nor

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FROM the dawn of civilization man has used fuel of one sort or another to create heat and power. He has been able to do this with no thought of the morrow, because his demands for heat and power were absurdly small. Today this is no longer the case. We use heat and power on such a scale that our coal, which seemed inexhaustible to the eighteenth-century pioneers who first worked out the modern methods for utilizing it, if not approaching the point of exhaustion at least is plainly moving in the direction of exhaustion. For other fuels the same or a more emphatic statement might be made. Shall we always have to rely upon the burning of fuel in order to get power? Obviously an affirmative answer to this question means that civilization must slow down, if not actually run down. But before giving a negative answer, before extending to civilization the fresh lease of life which such an answer implies, we want to be pretty sure we know what the alternative is and how we are going to use it. In the present article, the first of a series of three, Mr. Claudy shows what the alternative is not, and indicates what it must be. In the following members of the series he will show how we must even now prepare to follow that alternative, and lay today the foundation for the comparatively fuelless technology of a hundred years hence.—THE EDITOR.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Thermal Value of Coals

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of May 1, 1920, Mr. Henry Townsend, in his article on "The Fuel Case of Coke vs. Coal," makes some statements concerning the heating value of coal that I think are slightly inaccurate. He says in part: "Laboratory tests . . . prove . . . that there is no fuel resembling coal which gives a greater production of heat, pound for pound, by any combustion, than high-grade A-1 anthracite or hard coal such as that coming from the leading Pennsylvania coal mines." He then goes on to say that this coal gives 14,000 b.t.u. per pound. I would like to call your attention to the fact that the best anthracite coal rarely goes over 14,000 b.t.u., while by far the greatest part gives very little more than 13,000, and much gives less than 12,000. On the other hand, semi-bituminous coals such as Georges Creek Cumberland often give over 14,600 and values of 15,000 are not unknown. The reason for this is that the semi-bituminous coals contain more of the volatile hydrocarbons, which have considerable heat value, than do the harder anthracites. For authority as to these statements I refer you to the third edition of "Steam Boilers" by C. H. Peabody and E. F. Miller, New York, John Wiley and Sons, 1912. pp. 51-9.

ROBERT B. DONWORTH.

Boston.

Speed Maniac versus Pedestrian

To the Editor of the SCIENTIFIC AMERICAN:

The plan of Monroe Woolley in the SCIENTIFIC AMERICAN of April 24 for more liberty for the "speed fiend" and less liberty for the pedestrian seems unreasonable.

A "speed fiend" is such because he lacks common sense, and he is an infernal nuisance either in the city or country. Mr. Woolley says that if pedestrians were prevented from crossing the street "the speed fiend could be permitted to feed the motor all the gas it might crave."

If such a man was let loose on Broadway or Fifth Avenue, what would happen?

To accommodate him every pedestrian, including the aged and infirm, would have to descend about 20 feet, pass under the sewer, water and gas pipes, etc., and then climb up again, and incidentally the city would be put to enormous expense. If a man buys a second-hand flivver that fact should not put him in a privileged class and bar from the free use of the streets those who prefer to walk. There are certain penalties connected with life in New York. One is that a speed fiend must slow down at the cross streets. He would be compelled to do this to accommodate the crosstown traffic even if there were no pedestrians.

W. Hartford, Conn. X. Y. Z.

Gilding the Lily

To the Editor of the SCIENTIFIC AMERICAN:

A constant reader of your valuable papers for many years, as my bound volumes for well over 20 years will testify, I have never taken any part in the (sometimes amusing) squabbles in your correspondence columns, but the "spirit moves me" now to remark that the second paragraph of Mr. McClure's letter on "The Efficiency of Gases in Cutting Operations," issue of May 1st, seems to be in company congenial—a fitting companion to the adjoining excursion of the "cub reporter" into astronomical lore.

It is the more remarkable in that it occurs in what is apparently a sound article otherwise, though I have not gone to the trouble to verify the exactness of his statements.

"Oxide of iron burns!" Shades of the immortal Priestley ! ! What does *burn* mean?

HARRY STEWART.

Gettysburg, Pa.

A Wireless Incendiary?

To the Editor of the SCIENTIFIC AMERICAN:

Can oil wells be set on fire by wireless messages or static current? Many wells and rigs burn down in this field almost every day and some days I have seen as many as three burning and the real cause of the fire is rarely known. I have formed the idea that the long guy-wires from the oil-soaked rigs pick up wireless signals when they happen to be the right capacity for tuning and the little sparks shoot off and catch the gas or oil. On the evening of April 20 one flowing well caught fire for no apparent reason. There was no one about the well when it caught. I was some distance away. I heard a slight explosion and saw the black smoke shoot up the derrick. The same evening I saw three other big fires of oil tanks and rigs. I also read in the paper today where on that date there was a powerful wireless station trying to communicate with Mars. This station is in Nebraska.

There was another odd incident. We had a string of 8-inch casing 2,200 feet long stuck in a well. All efforts failed to pull it out. We shot it in at 2,100 feet with one quart of gelatine. We lowered the shot in the hole on a steel wire and fastened to the shot was a strand of No. 14 rubber-covered wire to set it off. The jar from the shot broke the copper wire loose and all went down in the well. We ran a fishing tool and brought the wire out in a twisted mass. The wire was popping and snapping and sparking and heavily charged. What caused it to be charged? The only current that had been put into the wire was the high tension current from the magnets to set off the shot but the wire had of course been disconnected from the magnets when it dropped in the well.

R. M. MCLAIN.

Desdemona, Texas.

Why Not?

To the Editor of the SCIENTIFIC AMERICAN:

I have read with interest the accounts in your columns and elsewhere of the enormous freight congestion in and about New York. Recently I had occasion to sail up the Hudson River close in to the Manhattan pier-heads, and to observe this congestion at first-hand. It came fully up to specifications—it was simply immense.

It seems to me that the remedies proposed fall short of hitting the fundamental cause. If you will examine a good map of Chicago and its vicinity, you will find a thin black line circumscribing the city completely, from lake front to lake front again, at a distance of twenty miles or so. The Elgin, Joliet and Eastern Railroad does not enter the city, yet it is an indispensable part of Chicago's rail system. Freight billed through Chicago, instead of being hauled into the city yards to create and participate in a monumental congestion, passes around the city via this belt-line. The E. J. and E. crosses every trunk line that enters Chicago; cars are transferred from any of these lines to any other by passing over it. To make it a certainty that nothing goes into the Chicago terminals that does not have to go there, there are numerous smaller connecting lines between two or more roads, at points nearer the city than those where the big connecting line taps the various trunks.

At Buffalo and Philadelphia there are similar arrangements, whereby even through passenger trains pass around the city instead of through it. In scores of other large traffic centers we find this scheme for routing through freight in such a way that there is no conflict or confusion between it and goods actually destined for city delivery. But New York, the biggest traffic center in the country, is the one place where nothing of the sort has been intelligently attempted. Of course there is some separation here and there. But for the most part everything consigned to New York or routed through New York is dumped in one wild scrambled mess along the shores of the Hudson River to be untangled as best it can.

Why has nobody ever had the common sense to build a connecting road from the Sound shore above New Rochelle, across Westchester to some point on the river above Yonkers, over to, say, Nyack by car ferry, and then around through the hills of North Jersey and down the Raritan valley to the Amboys? Of course the route which I outline here is purely a tentative one—what I have reference to is the idea of such a line. Why has it never been built or, so far as I know, even proposed? With a connecting line of this sort, New York could eliminate its present absurd scheme of handling its rail-borne freight, and adopt in its stead the same rational method found in every other large American traffic center. Why pass through the neck of the bottle when it is possible to go around it?

A MERE LAYMAN.

Concrete Without Dampness

To the Editor of the SCIENTIFIC AMERICAN:

Referring to a letter in your issue of February 14, 1920, on the "Concrete House," it may be of interest to your readers to learn how I avoided the dampness usual in such constructions when the walls are solid. In building a concrete wall on the north side of a greenhouse, the thickness being 6 inches, planed pine boards 1½ inches thick and about 12 inches wide were set on edge in the middle of the space between the sheathing into which the concrete was poured. These boards were well greased; had handles on the upper edge; were 6 or 8 feet long, and between the ends of two adjoining boards a space of 8 inches was left. The concrete was poured in the usual way, and after it had hardened somewhat but not enough to retain the boards, they were raised by the handles, but not entirely out of the concrete and a new layer of concrete was poured. The result of continuing this process was that when the wall was finished there was a series of air spaces, separated by solid posts, at the spaces between the ends of the boards. The wall was sufficiently strong to support the roof and was dry, and needed no furring or water proofing. Such a process is very simple, costs little but the trouble of doing it, and in a dwelling would give a dry warm house, which would require only the cement wash for appearance outside, and the white coat on the inside applied directly to the concrete surface.

The length of these air-space-forming boards would naturally follow the design of the house. In most houses an air space most of the distance between windows or doors, with solid concrete against the frames would give a dry, strong and warm wall; and the small expense of setting the boards, and raising them before each layer was poured would be compensated by the saving in concrete. SAMUEL B. LYON.

New York.

Not So Absurd as It Seems

To the Editor of the SCIENTIFIC AMERICAN:

In your editorial of May 22nd, entitled "The Serious Traffic Situation at New York," there is the following statement: " . . . . two hundred million dollars a day is wasted in this city because of our extravagant methods of distribution, and it should be remembered that every person living on Manhattan Island pays his share to meet this altogether unnecessary expense."

If this is the case it costs every individual on Manhattan Island approximately fifty dollars a day or about eighteen thousand dollars a year. It costs the average family of five ninety thousand dollars a year and the saving in one year's time if the traffic situation could be satisfactorily improved, would be approximately seventy-two billion dollars, or about three times the indemnity which it is now proposed to require from Germany.

We quote from your editorial of May 1st, entitled "A matter of Common Sense":

"But it is neither credible nor respectable to discover that such an outrageous perversion of facts and common sense can be written by a reporter, get past his superiors, and run the gamut of the linotype and the proof-reader and the make-up man without meeting a single soul who is competent to expose it."

GUY GIVEN,
ZENO OSTENBERG.

Stamford, Conn.

[*Our correspondents have overlooked two features of this matter. In the first place, we did not say wasted in distribution, but through the methods of distribution. That is to say, this total includes the loss to merchants through goods which they cannot receive or cannot ship promptly, the loss to manufacturers on the same grounds, lost labor, et cetera. In the second place, more manufacturing is done in New York City than in any other equal area in the world, and it is in addition a center of distribution for goods made all over the world. The burden of the* $200,000,000 *is shared by everybody who ever buys anything made in or transported through the city. The editorial statement that every Manhattanite pays his share was directed at the residents of Manhatian and their governmental agencies, and ignored the share paid by outsiders, purely in the effort to bring home to the city Government the fact that something could profitably be done to remedy the situation.*—THE EDITOR.]

The Silent Teacher

How and Why the Motion Picture Is a Great Force in Explaining Technical Things

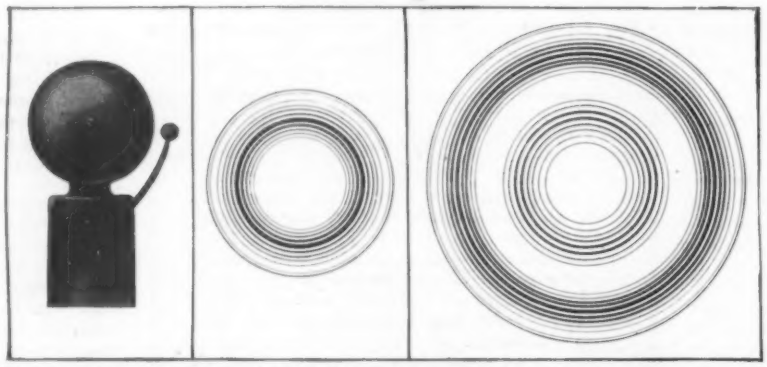
By Jerome Lachenbruch

A STRIP of celluloid is transforming modern educational methods. Heretofore, the school teacher has had a threefold problem to face. Every educational method tries to arouse the pupil's curiosity, stimulate his interest and free his imagination. To obtain results, the teacher has only the five senses of his pupils to play upon. These are the channels of learning, with the visual sense by far the most active in the absorption of information.

The difficulty of the instructor's task is not only a psychological and a biological one, but is also compounded by a practical obstruction. The student may be temperamentally prejudiced against a particular subject. So may the teacher; and as a consequence his lecture may not be stimulating. Moreover, both the child and the instructor have their "off" days, on which the learning process halts almost completely. Furthermore, the mechanical aids of teaching may be inadequate. It is an indictment of our entire public school educational system that the leisurely methods and the scientific aids now in use in some of the best equipped elementary private schools in America are unknown in the public schools. Besides, the present dearth of instructors, not to say good instructors, presents a practical obstacle which the very best of educational methods will find it difficult to overcome.

But an entirely new method is gradually attracting the attention of educational boards. With it no subtle effort on the part of the instructor is needed to arouse the pupil's interest or to stimulate his curiosity. This is due to the fact that it aims at instruction through the medium of entertainment. That is what the modern educational motion picture is doing. The making of the educational film has gone through several phases; but an experiment successfully tried during the war has proved the practicability of making this type of film by a new process.

At the West Point Military Academy, previous to our entry into the war, the manual of instruction on the constitution and operation of bombs was supplemented by a lecture course of twenty-four teaching hours. The Government commissioned Lieut. F. J. Leventhal to make a picture of the processes involved, with the result that the course was reduced from twenty-four hours to fifteen minutes.



How sound waves from an electric bell are shown: First is the drawing on opaque gray board, and then two successive drawings on celluloid

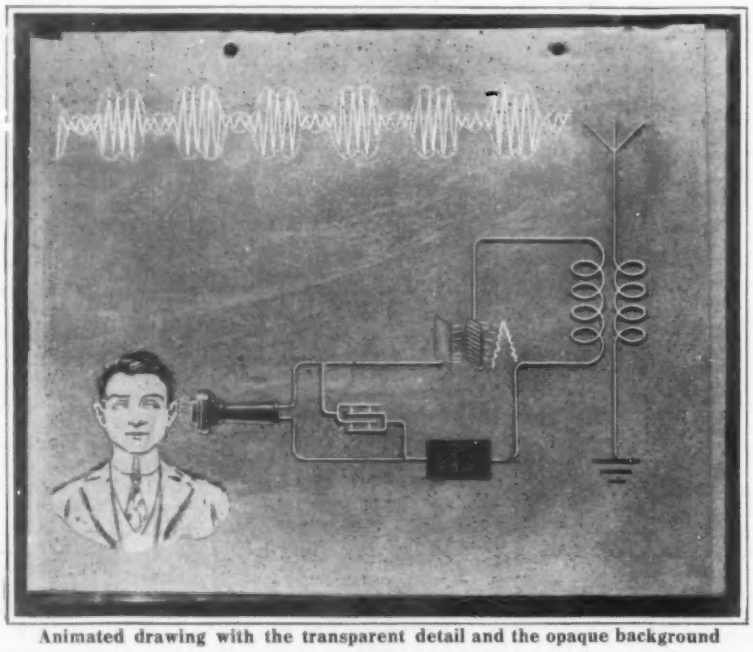
This new type of educational picture is called the animated technical drawing and is a development of the animated cartoon. The process by which these films are made consists of photographing about 1,500 individual drawings and explanatory titles on a roll of motion picture film. The drawings are made on thin paper and then traced on transparent composition plates. These plates are numbered and exposed to the camera in succession. As in the motion picture taken from life, it is often necessary to emphasize certain phases of the subject. Moreover, the same drawing may be used in several places to tell the story clearly. This is comparable to the use of what is known in motion photography as "flashbacks." In the animated technical drawing the result is achieved by photographing the drawing desired in its regular numerical order and again inserting it at some later point in the picture. For example, drawing number 9 may be shown as the ninth picture on the reel, and may again appear in forty-fifth position when the reel is completed.

In photographing the transparent plates, it is often necessary to superimpose two or more of them and photograph them together. This is necessary to obtain the illusion of movement. It also obviates the necessity of making an indefinitely larger number of drawings than are now used in a single animated technical drawing.

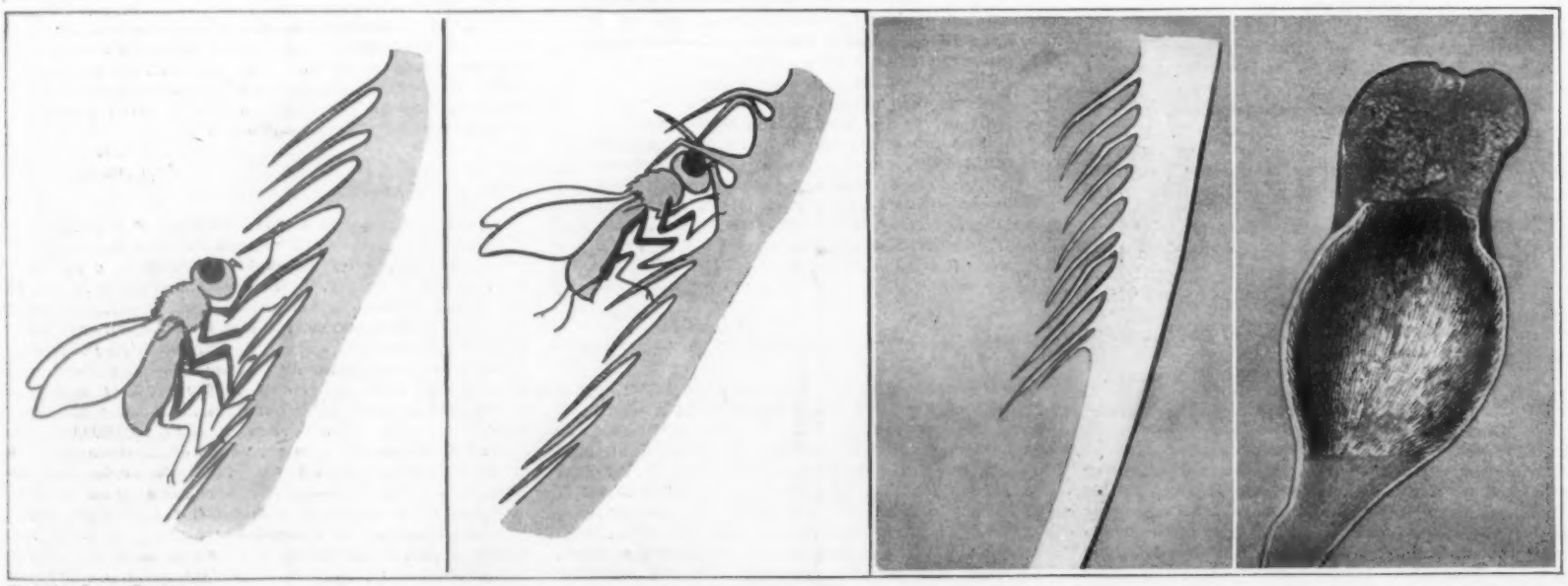
The principle on which this phase of the work operates is based on the fact that several pictures are alike except for minor changes. If a flower is to be represented as blossoming, the stem remains the same throughout the process. Consequently, a transparent plate showing only the stem is photographed as a background with a succession of other drawings that reveal the stages of the blossoming process. This results in a great economy in the number of drawings to be made, as well as in a saving in time. In fact, if this idea had not been reduced to an economically scientific basis, the so-called technograph drawings that have been developed would not be practicable.

In all the subjects several dark-toned backgrounds are used with the transparent plates. An instance of this may be seen in a physiological study showing the action of the human heart. The heart is first photographed from a dark cardboard background; then a transparent plate on which the chambers of the heart are drawn in outline is superimposed, and the two drawings photographed together. Several other plates showing changes in the chambers are then laid over the background and photographed. Of course, several different backgrounds are used; but a single

(Continued on page 714)



Animated drawing with the transparent detail and the opaque background



Illustrations Courtesy Boz Studio

Details of "The Pitcher Plant," showing two of the transparent drawings of an insect climbing up the side of the interior; a section of the interior with its bristles, drawn on opaque gray paper; and a sectional view of the plant

Mashing Copper Cylinders to Test Road Impact

THE force of impact exerted by heavily-laden motor trucks or other cargo-carrying vehicles on public highways is knowledge of prime consideration to the designing engineer in his calculations for determining how thick a road surface should be, but scientific data on the subject has been lacking heretofore. Like many other important contributions the searching eye of war efficiency emphasized the significance of devising methods for ascertaining the impact pressure produced by vehicles groaning under the immensity of their tonnage.

In fact, the principle employed in measuring the pressure in big guns while being discharged is now applied by the United States Bureau of Public Roads in revealing the stress of motor-driven vehicles on the road. The truck, while in motion, is permitted to fall from varying heights in such a fashion that one rear wheel strikes a platform, which is mounted on the plunger of a hydraulic jack. The blow from the colliding wheel is transmitted through the plunger to a copper cylinder, one-half inch in diameter and one-half inch high. The force of the stroke levels downward the copper cylinder, shortening the device, which in turn registers a permanent record of the magnitude of the blow from the motor truck wheel.

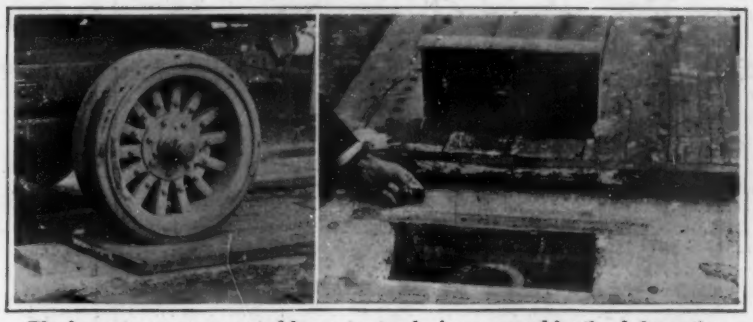
By compressing duplicate cylinders in testing laboratories it can be readily determined from readings of the experimental machines exactly the quantity of pressure corresponding to the amount of curtailment of the cylinder due to the stroke of the truck. Already, in this way it has been deduced that the force of the blow, measured in terms of the weight of the truck wheel, is from five to six times that of the weight when at rest on the road surface.

When it is estimated that for the current fiscal year in excess of $600,000,000 will be available for road construction, the elaborate tests of the U. S. Bureau of Public Roads to determine accurately the force of impact from lumbering motor vehicles should be a practical contribution in placing road designing on a rational basis.

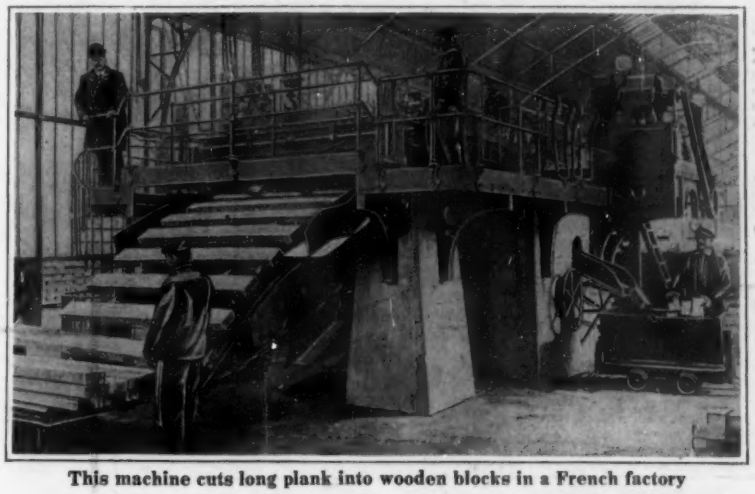
The experience of the spring of 1917 has not been effaced from memory. With the extensive use of immense army trucks, loaded to their guards with freight accumulated by the results of a railway system then staggering toward a collapse, many highways failed in the critical test. They crumbled under excessive burdens. Seasonal changes likewise influence the sustaining power of highways. For instance, during the spring when the frost is working upward out of the ground, the soil is generally of a soft, pliable nature. Consequently, highways are incapable of standing up under enormous loads.

Were it not for the absence of the sustaining power of the underlying soil the prevailing systems of highway construction would offer few of the perplexities now inviting the services of engineering skill. Even under the adverse conditions of abnormal burdens from heavy motor trucks, highway-maintenance troubles would be kept at a minimum. It is not so ordered.

Did you ever stand by the roadside and watch the world go by? If so, you doubtless felt the vibrations of the road surface during the passage of swiftly moving motor trucks. The considerable impact on the highway surface from the effect of the wheels must have been evident—much greater than when the vehicle is at rest on the road. Recognition of this principle is responsible for the first attempt ever made to obtain definite information as to the actual stress of this impact—hence the series of experiments now in process of unfolding by the U. S. Bureau of Public Roads.—By *S. R. Winters.*



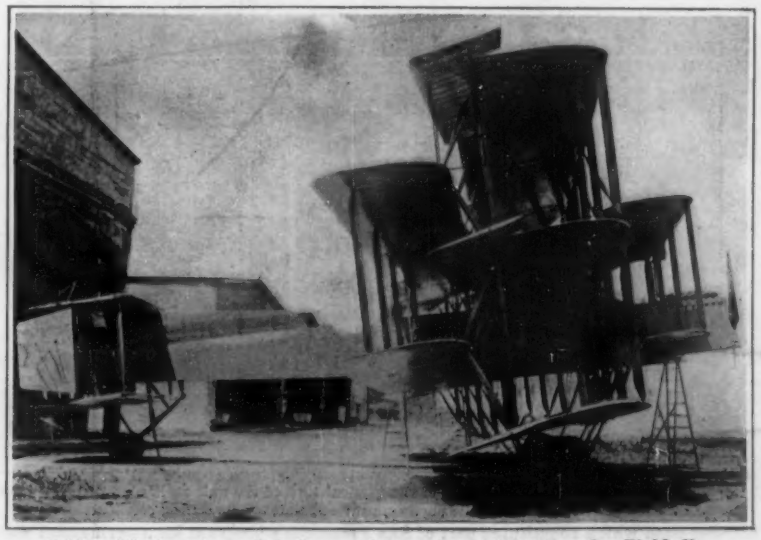
The impact pressure exerted by motor trucks is measured by the deformation of the copper cylinder placed on the plunger of the hydraulic jack



This machine cuts long plank into wooden blocks in a French factory

Copyright, Underwood & Underwood

Life-test racks on which hundreds of lamps are tested by the Bureau of Standards



Odd multi-plane type of airplane which awaits a trial at Langley Field, Va.

From Big Blocks to Small Blocks Automatically

THE so-called "American system," which in Europe may mean anything from an automatic lathe to an entire quantity production system—anything, in fact, that replaces hand work to a more or less degree, is gradually extending in every country. Until recent years the Germans were perhaps the only Europeans who had some conception of real quantity production, but today, partly because their present desperate needs demand such a remedy for underproduction and partly because their recent close contact with American methods has impressed so profoundly upon them the efficacy of these methods, the French, Italians, Belgians and others are turning to labor-saving devices.

The machine shown in the accompanying view is interesting in this connection. It is a French machine designed to cut 24,000 wooden blocks an hour, and is being extensively used for making paving blocks. It not only saves much time and labor, but it makes for less waste than the former method calling for a circular or band saw. The special feature of the machine is that it cuts every plank into sixteen blocks at one operation. The blocks are carried away by an endless belt and delivered to the truck.

How Long Will an Electric Lamp Last?

DOWN in the Bureau of Standards in Washington, D. C., electric lamps are given a very practical test to determine their life. While the test covers only Government supplies, the data thus secured may furnish a check on similar tests of lamps for commercial channels which are made by high grade factories.

The method of testing electric lamps at the Bureau of Standards is shown in the accompanying illustration. The lamps to be tested are placed on the life-test racks, and are burned to determine how long they will last and how rapidly they decrease in candle-power because of blackening. The lamps thus tested are samples chosen from packages supplied on Government orders by lamp manufacturers. If the samples do not give the service required by the standard specifications, the lamps which they represent are rejected by the Government.

Is the Multi-Plane Airplane Practical?

THAT question, precisely, is what aeronautical experts have long sought to answer to their own satisfaction. From time to time multi-plane machines—machines in which two or more sets of planes are arranged in tandem—have appeared and have undergone actual tests, but as a whole the results have been disappointing. Indeed, it has come to a point where the tandem arrangement of planes is not looked upon as a very practical one; but the ever-increasing demand for greater carrying capacity seems to have again brought the multi-plane idea before aeronautical engineers, and a good many machines which might be described as freaks, but which represent the designer's effort to increase lift by increasing lifting surface, are being put forward.

The latest multi-plane machine to be constructed full size is now being exhibited at Langley Field, Va., preparatory to a series of flying tests. It is a unique affair, to be sure. The main part of the machine consists of a triplane arrangement, but right behind this and arranged midway between the triplane wings is a biplane arrangement. Evidently the designer of this machine has endeavored to get more wing surface with a minimum of interference. Whether he has succeeded or not remains to be proved. The fact is that this machine has plenty of power—two engines for propellers and one engine for a tractor screw.

San Francisco Goes to the Mountains

Some Details of the Lake Eleanor Dam, Part of a Comprehensive Water-Supply Scheme

By J. F. Springer

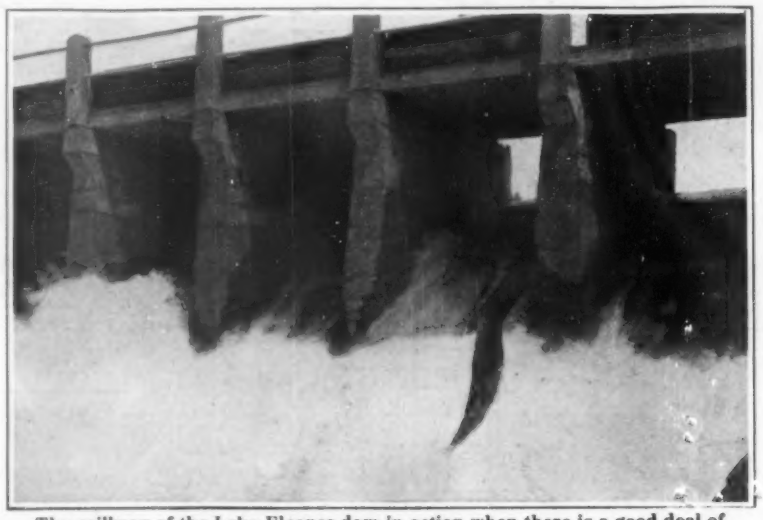
IN the foot hills back of San Francisco at an elevation above the sea of a little less than a mile is a beautiful sheet of water known as Lake Eleanor. It covers part of a little watershed adjacent to the world-renowned Yosemite Valley. This lake has recently been enlarged by damming the outlet. The enlarged body of water will form the most elevated reservoir of the great water-supply system now being constructed by the city. The total of water from the tributary watershed of Lake Eleanor will constitute only a fraction of that involved in the general scheme. It is, however, the first to be impounded.

The construction of the necessary dam involved a number of subsidiary problems. The material used was concrete. Nature furnished close at hand the necessary gravel and the necessary sand. But one could not expect her to supply the Portland cement so conveniently. A great deal was required and the problem with respect to it was one of transportation. And it proved to be a serious one. Another problem centered on the forms for the concrete. This did not turn out to be anything difficult. Saw mills are transported into the woods and set up with too much ease in the present day for that. And suitable timber was near at hand.

But while it is one thing to pick out a site for a dam, it is another to prepare the foundation. In the present case, it was not permissible to wait until the new road was constructed and then transport machinery for the necessary excavation. Time pressed, because of need for a water supply for a temporary power-house whose function was to supply power for construction purposes for the whole project. Hand-operated derricks were consequently employed on the excavation. Hand tools and other necessities were taken to the scene of operations without waiting for the new road and the site was duly prepared.

The wagon road was constructed, for a considerable part of its total length of fourteen miles, in the solid granite of the foot hills. In a distance of 3½ miles the road descends 1,800 feet. The slope for this rise is an almost continuous 12½ per cent grade. The difficulties of location may be glimpsed upon grasping the fact that there are 13 switchback turns and that most of these require an auto-truck to make several reversals. A wooden truss bridge was constructed to carry the road across the Tuolumne River. The span here was 168 feet and the roadway was put at a level of 50 feet above the stream. The small saw-mill, whose product was especially desired for concrete forms, manufactured in half a year some 900,000 board-feet of lumber. The foundation level for the dam was carried down several feet below seams in the granite.

A very solid foundation was required by the character of the structure. Its design belongs to the type known as the multiple-arch dam. There are two broad classes of arch dams. In those belonging to the one, there is a single rounded arch whose convexity faces the oncoming water. Moreover, the arch is tilted so that the crest is farther downstream than the base. Such a dam resists the forward thrust of the water differently from the way in which the gravity dam resists it. In the latter case, there is a horizontal forward thrust resisted by weight, the thrust becoming greater and greater as the depth of the water increases. With the tilted arch there is, first, the arch effect which transfers a part of the thrust to the abutments. Then a large part of the pressure against the tilted surface is converted into vertical pressure on the foundation. Finally, the weight and frictional resistance against movement enter here in a small way. The multiple-arch dam consists of repetitions of small tilted arches. With it, the abutments play little or no part with respect to the dam as a whole. The arch action is transferred by each arch to its foundation and perhaps more or less to adjacent arches. Otherwise than as described, the multiple-arch dam is equivalent to the single-arch structure. Naturally, the multiple style is used where the total span is considerable. At Lake Eleanor there are twenty small arches each having a span of about 40 feet. At each end of the series of arches is a short gravity section. On the one end this merges into a spillway section some 200 feet long. The spillway is provided with 25 openings set at intervals of 8 feet, center to center. The dam as a whole is not perfectly straight, being convex toward the upstream side.



The spillway of the Lake Eleanor dam in action when there is a good deal of water to be carried off

A little consideration will, perhaps, prepare the reader to grant that a dam of this type can probably be built with much less concrete than would be the case with an ordinary gravity dam. Weight is no longer the vastly important thing. Resistance to crushing action has been substituted. This is a quality possessed in very good degree by concrete. Arched dams, especially those with a plurality of arches, are becoming popular in the Far West. While they are rather new in engineering practise, they are not so new as not to have been backed by favorable experience.

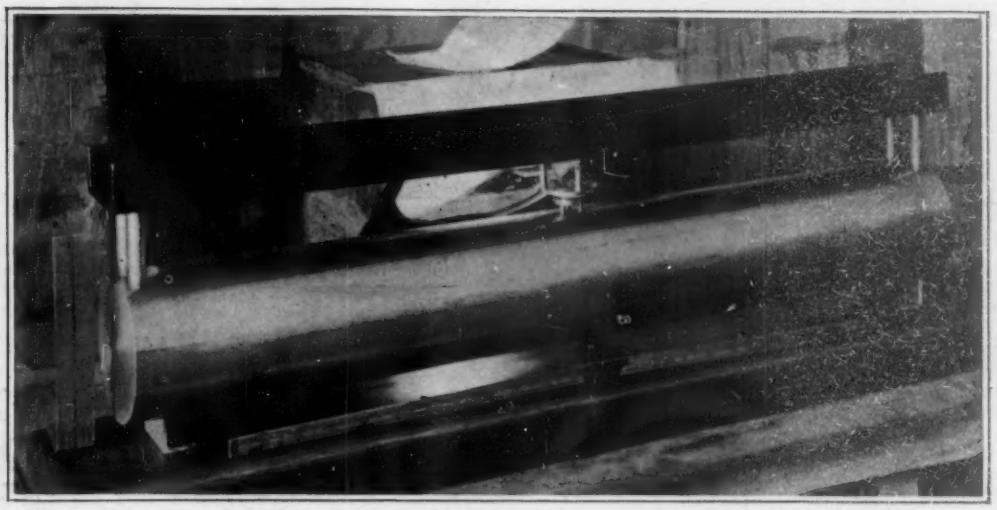
One of the prerequisites for a multiple-arch dam appears to be a site where a thoroughly solid rock foundation may be developed. It is understood that the practical height of such dams is limited to about 125 feet, because of the rapidity with which the cost rises for greater heights. However, in some of the cases where great height is required, the single-arch dam will be applicable. Thus, where the span is not excessive and the canyon V-shaped, the single-arch dam may very well become a competitor against other types.

Multiple-arch dams are sometimes, perhaps always, built with some proportion of reinforcement in the concrete. Now the very reason for adding steel to concrete is to endow the latter with tensile strength in which it is naturally very deficient. And, in these dams, it has been stated with authority: "Under all conditions of water load the arches are prac-

(*Continued on page 716*)

1. General view of the partly constructed dam, showing the bend and the vertical tops of the unit arches. 2. The roadway on the crest of the dam.
3. Looking downstream upon the partly unwatered unit arches during construction.

The Lake Eleanor dam which constitutes part of San Francisco's program for a permanent water supply



At left: Dark bands caused by the interference of light waves reflected from two nearly flat and parallel surfaces very close together, and establishing a measuring unit of 10 millionths of an inch. *At right:* Arrangement for detecting a bending of one millionth of an inch, caused by the downward pressure of one pound in the middle of a four-inch-diameter steel bar.

Two examples of how light waves may be employed in measuring objects to a fineness of millionths of an inch

Measuring Deflection with Interference Bands

By H. L. Van Keuren

A CERTAIN manufacturer, commenting on certain difficulties met in his shop, complained that a large slab of cast iron, used as a layout slab for precise work, was just about as stable as a big piece of jelly. One of his mechanics, who really knew his grinding machine and who could do the most exacting work on it, demonstrated how the machine would remove just the right amount of metal when adjusted for a very fine cut, but would not grind at all if thereafter he rested his hand on the massive and supposedly rigid base.

These incidents directed attention to the fact that there is no such thing as absolute rigidity. Ordinarily if one were asked to bend a piece of four-inch-diameter cold rolled steel shafting, one would hesitate to consider just what type of hydraulic press or bulldozer would be required. Indeed, there are few who realize that it is possible to bend it with the unaided human fingers, yet the solid steel bar shown in one of the accompanying illustrations has been bent in such a manner by more than a thousand different people, all of whom were cautioned not to press too hard on the bar, in order that they might realize better the effects of the slight pressure in bending the bar.

This steel bar, which is a little over four inches in diameter, is supported at each end by an angle iron, the supports being about 28 inches apart. At the top of the bar at each end there are screwed two studs which support a channel iron approximately the same length as the bar.

Now in the middle of the bar is attached a little table, which in turn carries a small piece of metal, having a flat polished surface which serves as a mirror to reflect light. Attached to the channel iron is a flat piece of glass which is directly above the metal mirror. The glass is very close to but is not touching the mirror, and furthermore the glass is very slightly inclined with reference to the metal mirror. This mirror on the bar, and the piece of glass above which has no direct mechanical connection, constitute the essential parts of the apparatus which discloses a very slight movement of either the bar or the channel iron.

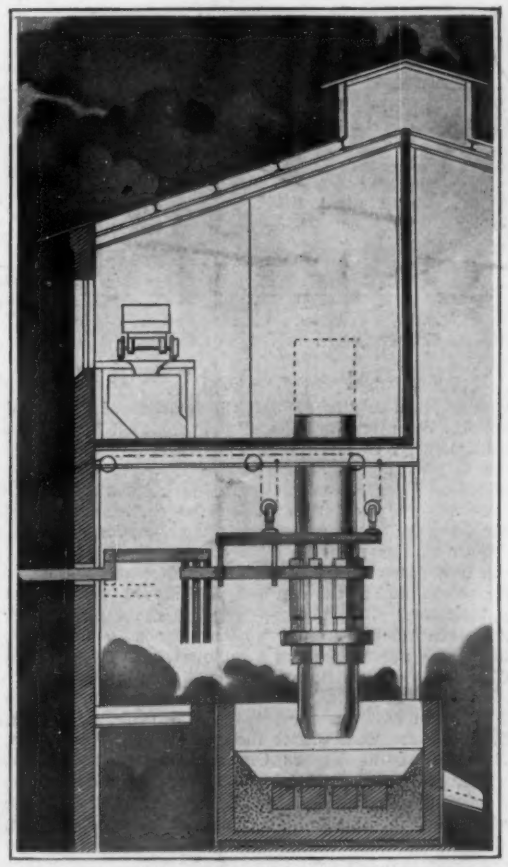
The SCIENTIFIC AMERICAN has described the phenomenon of light-interference bands on numerous occasions, and has made it clear how these bands are used to effect fine measurements. The same principle was employed in the case under discussion. If we may repeat briefly the statement of the principle, it is that when monochromatic light (light of one color) is reflected from two nearly flat and parallel surfaces very close together, a series of alternate light and dark interference bands are discernible. These alternate light and dark bands occur due to the fact that the light waves reflected from one surface are in step (producing light bands), or are out of step (producing dark bands) with the light waves reflected from the other surface.

Such a series of interference bands is shown in the figure where an optically flat glass is resting angularly on a flat metal gage-block. The optical flat glass is in contact at the right hand edge of the gage and is sloping upward from the gage toward the left at the rate of one one-hundred-thousandth of an inch (0.00001 inch) per dark band. When the glass is pressed downward, excluding some of the air film between the glass and the gage, the interference bands move. They move in one direction when the glass is pressed downward, and in the opposite direction when the glass is lifted away from the gage.

Referring again to the apparatus we are describing, there is emitted from the light box in back of the steel bar a monochromatic light from an incandescent lamp, passing through a special selenium glass. This light is directed downward by a plane piece of glass placed at an angle of about 45 degrees on the little table under the channel iron. Some of this light is reflected upward by the metal mirror on the bar, and some of it is reflected by the adjacent surface of the glass on the under side of the table attached to the channel iron. This light which is reflected upward is seen through a hole in the channel iron.

Now the optical conditions between the metal mirror on the bar and the adjacent glass on the channel iron are exactly the same as between the gage and the glass

(*Continued on page 716*)



Cross sectional view of an electric ferro-silicon furnace using the self-baking continuous electrode

An Electrode That Bakes Itself

By A. R. Surface

A DECIDEDLY novel and interesting development which may play an important part in the American electro-metallurgical industry has recently been made public. It is a new kind of carbon electrode—one that is self-baking and continuous. It is known as the Soderberg self-baking continuous electrode, from the inventor, a Norwegian.

The general idea calls for a self-baking electrode formed continuously from a soft carbon mixture, which would be baked in the same furnace in which it is used and thus provide a continuous electrode. The first electrode of this kind was built by Mr. Soderberg in 1909. He naturally met with many difficulties in developing his idea, and it was not until 1915 that he actively pushed the development in connection with the company with which he is now engineer.

After considerable development work, the company succeeded in overcoming in a practical manner all of the difficulties, and in November, 1918, a 400-mm. (16-inch) electrode was operated on a ferromanganese furnace without disturbance to the furnace and with no fracturing of the electrode. Since that time electrodes of all sizes up to 850 mm. (34 inches) have been successfully operated in both open and closed furnaces in making ferrosilicon, silicomanganese and ferromolybdenum.

This electrode may be in general described as embodying the idea of feeding continuously unbaked electrode mixture to the furnace, the mass being baked by the heat of the furnace in which it is being used, and the apparatus being so arranged and worked that the operation is practically continuous during the life of the furnace. The idea therefore entirely dispenses with the use of previously-baked electrodes and with their replacement or introduction from time to time in the furnace. In operation, the baked end of the Soderberg electrode is always in the furnace, while the unbaked part is outside and can be lengthened from time to time as the electrode is consumed. The heat necessary to bake the mass is conducted from the lower baked end, or contributed by hot gases or radiation, or partly derived from the passage of current through the baked part.

The electric current is best introduced at the lower or baked end of the electrode, where the hot carbon becomes conducting, but may, in small electrodes, be introduced higher up if an iron casing is provided to carry the current from the unbaked part to the baked part of the lower end. In usual practise the movable electrode holder is placed near the top or roof of the furnace, and encircles the iron casing in which the electrode mixture is encased. The baking takes place comparatively close to the furnace, usually at a small distance above the electrode holder, when the latter is in its usual position encircling the electrode close to the furnace. If the design of the furnace requires it, the electrical connection may be made higher up, or further from the furnace, especially with smaller electrodes, but in this case the iron shell must be heavy enough to carry the current past the unbaked mass to the baked and conducting part of the carbon electrode.

The raw electrode mixture is practically the same

(*Continued on page 717*)

The Heavens in July, 1920

Where Matter Moves Seven Hundred and Fifty Miles a Second

By Professor Henry Norris Russell, Ph. D.

ANNOUNCEMENT which has just come in from the Lick Observatory throws a very interesting light upon the complex, but fascinating problem of the "new" or temporary stars.

It has been known for about twenty years that these strange bodies, as they go through their rapid changes, follow a fairly definite law. The original outburst is extraordinarily rapid, and brings the star from a faint telescopic object—sometimes indeed from invisibility—up to many thousand times its original brightness within a couple of days. This great brilliancy is almost as short-lived as the increase in light, and there follows a steady fall in brightness broken by irregular fluctuations, so that at the end of a year the object emits perhaps one per cent of its maximum light, while in a decade it has fallen almost to its original luminosity. As these changes in light go on, the spectrum undergoes equally remarkable variations. The few observations that have been made during the increase of brightness show a spectrum of the ordinary type, crossed by dark lines—which, however, are much displaced from their normal position. Just as the maximum light is reached the spectrum changes into a flaring affair, full of bright bands, flanked by dark lines on the side of shorter wave-length, toward the violet. The lines of hydrogen are most conspicuous, but helium is also present, and other bands can be identified with "enhanced" lines of some of the metals—that is, lines which are produced in the laboratory when the metallic vapor is very strongly excited to luminosity by a powerful electric spark. Later on, as the light begins to fade, the characteristic nebular lines in the green and violet make their appearance, and become the most conspicuous feature of the spectrum, while the other lines fade away. At a still later stage the spectrum resembles that of the nucleus of a "planetary" nebula, or of one of the Wolf-Rayet stars which are found here and there in the Milky Way.

What We Read in the Spectroscope

Half a dozen different novæ have exhibited essentially this same spectroscopic behavior, with minor differences from star to star, and it is evident that the strange sequence of changes represents a pretty definite physical process—but what can this process be? Probably the easiest evidence to interpret is that furnished by the widening and displacement of the lines in the spectrum. The bright bands, though enormously widened, are not greatly shifted in position—that is, they spread out on each side of the usual position of the line, toward both the red and the violet, so that the center of the line occupies substantially its normal position. The dark lines, on the contrary, are all enormously shifted toward the violet—so far, indeed, that it is not an easy matter to identify them at all. Those which correspond to the bright bands lie exactly at the edges of the latter, on the side toward the violet.

The widths of the bright bands, and the displacements of the dark lines, which are evidently just one-half as great, are greatest in the red and least in the violet parts of the spectrum—being, in fact proportional to the wave-lengths of the lines. This is the characteristic effect produced by motion in the line of sight, and not at all similar to the influence of pressure, which widens and shifts different lines by irregularly varying amounts.

But if the behavior of the lines is due to motion of the gases which produce them, why should the bright bands be greatly widened, and not shifted bodily, while the dark lines are shifted, and much less widened?

The explanation is found in the bold hypothesis that the star is surrounded by a shell of incandescent gases, ejected from it at the time of the outbeak, and expanding in all directions. The absorption lines will be produced by the part of this shell which lies between us and the star. Here the gases will be moving toward us,—hence the lines will be shifted toward the violet. The bright emission lines, however, will be given out by all parts of the expanding shell. The light from the nearer side, which is approaching us, will give lines shifted toward the violet; that from the farther side, which is receding, will exhibit an equal shift toward the red; while the light from that part of the shell which is moving at right angles to the line of sight will give undisplaced lines. Other parts of the shell will give lines displaced to all intermediate degrees, and the combined effect of the whole will be to produce a wide, diffused spectral band, with its center at the normal position, and extending equally far to the red and to the violet. Since the gas which produces the absorption lines is moving directly toward us, these will be displaced by the maximum amount, and will fall just at the edge of the bright bands.

A Monumental Velocity

No other simple hypothesis seems capable of accounting for the phenomena, and we have the high authority of Professor Adams for believing that this is the real explanation. The difficulty about it is the enormous magnitude of the velocity of expansion which is necessary in order to account for the facts. In the case of Nova Aquilæ of 1918, the hydrogen, helium and nebular lines were broadened and displaced for months continuously, to an extent which for explanation demanded a shell expanding with a velocity of 1,250 kilometers per second. Certain dark lines which appeared for a short time during the earlier history of the Nova indicated velocities even greater.

Now at this rate the expanding shell of gas would reach a diameter equal to that of Neptune's orbit in six weeks, and at the end of a year would be 24 billion miles across—260 times as large as the earth's orbit. Are such velocities credible? and, if they really exist, ought we not to see the luminous shell of gas as a disk of light—a little nebula?

It is to this question that the observations at the Lick have given a remarkable and decisive answer. Within four months after the appearance of the Nova, Barnard at the Yerkes Observatory noticed that it appeared in the great telescope not as a point, but as a small greenish disk, about a second of arc in diameter. Aitken, at the Lick Observatory, in September, 1919, observed this disk again, and found it 2.4″ in diameter, and conspicuously bluish-green. Photographs of the spectrum showed that the light of the disk came mainly from the nebular lines, which explained the color. A recent telegram states that Moore and Aitken, on June 9th of this year, found the disk to be 3.8″ in diameter. Putting these values against the time, it is found that the diameter of the disk is proportional to the time elapsed since the outburst of the Nova.

The Telescope Verifies the Tale

In other words, Nova Aquilæ is surrounded by a small gaseous nebula, which is expanding steadily at a uniform rate, and which apparently originated at the time of the great cataclysm. No more direct or more beautiful confirmation of Adams' hypothesis of the expanding shell could be imagined. The thing is there, visible in the telescope, and expanding in all directions before our eyes.

If we assume that the rate of expansion, in kilometers per second, is the same as that indicated by the width of the bands in the spectrum, it follows that the diameter of the nebula at present, two years after the outburst, is slightly more than 1,000 times the earth's distance from the sun. This would make the distance of the Nova about 900 light-years. Its brightness before the outbreak would then come out about twice that of the sun—a very ordinary dwarf star; while at maximum its luminosity appears to have reached the extraordinary amount of 150,000 times the sun's light. This is a startling figure; but the estimate of distance which we have just made is supported by the smallness of the proper motion of the nebula—only 0.018″ per year, which would correspond, at the assumed distance, to 24 kilometers per second, a very ordinary rate of stellar motion.

What causes a star, which has previously shown no peculiarities to speak of, suddenly to burst out into such enormous brightness, and to eject nebulous gases in all directions with prodigious speeds, we are as yet quite unable to determine. It may be the result of a collision, or of some sort of internal explosion within the star. We can be sure of one thing at least. These phenomena, which occur somewhere in the Milky Way fully as often as once a year, involve by far the most tremendous catastrophes of which the human race has at present any knowledge.

Perhaps the most impressive thought of all is that if our present estimate is sound, the catastrophe which we saw and recorded, here on earth, on the night after the eclipse two years ago, actually happened in the eleventh century of our era, long before William the Conqueror set foot in England.

At 11 o'clock: July 7.
At 10½ o'clock: July 14
At 10 o'clock: July 22.

At 9 o'clock: Aug. 7.
At 8½ o'clock: Aug. 14.
At 8 o'clock: Aug. 22.

At 9½ o'clock: July 30.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on July 7, etc.

NIGHT SKY: JULY AND AUGUST

The Heavens

Turning to the starry skies themselves, we find at our accustomed hour of observation the splendid group of summer constellations fully displayed in the southern sky. Sagittarius and Scorpio are in the south, clear of the horizon. Above them lie Ophiuchus and Aquila, with the grand star-clouds of the Milky Way. Higher still, practically overhead, is Lyra, with Cygnus below to the eastward. Cepheus and Cassiopeia, north of this, complete the list of the galactic constellations.

The eastern sky, below these, is dull except for the great square of Pegasus, and the far less prominent group of Capricornus. Opposite to these Virgo is setting, attended by Mars. Bootes is well up on the west, with Corona above and Hercules higher still. The Great Bear is sinking in the northwest, and Draco and Ursa Minor are above the pole.

The Planets

Mercury is an evening star at the beginning of July, setting at about 9 P. M. by standard time, and an hour later by the daylight-saving clock. He is easily visible for a week or more thereafter. Then he draws rapidly in toward the sun, passes through conjunction on the 27th, and becomes a morning star, to appear clearly in the following month.

(Continued on page 717)

Battery of twenty boilers employed in fighting the blazing oil well

Putting Out a Pillar of Fire

TO extinguish an enormous torch blazing 200 feet into the air recently called for decisive action on the part of a Western oil company, who fought the terrific flame with water, steam and mud, and finally conquered it with dynamite.

What is known as the Hay well, in the Elk Hills District, California, suddenly leaped to life while drilling was in progress and gassed so furiously that it set itself ablaze. The giant flame could be seen for a distance of fully 75 miles, and the ominous roar could be heard for 9 miles. This was the largest gas fire in the history of California and one of the largest in the United States. Two previous wells on the same property had come in as gushers, but their flow was considerably less than that of the Hay well, which was estimated at about 100,000,000 cubic feet per day. While the well was being driven with a rotary, what appeared to be water-sand was encountered at a depth of 2,135 feet. In order to test this sand for water, the mud was bailed out to relieve the pressure and to allow any water present to accumulate in the hole. While this work was going on, the well suddenly blew out and the enormous flow of gas started.

The top of the 12½-inch casing was equipped with a heavy gate valve and a 6-inch flow line that extended to the side of the derrick. The drilling crew made frantic efforts to get the well under control by closing this gate valve, but the shale and sharp sand that shot upward in the violent stream of gas cut out the seat of the valve while it was being closed. Then there was nothing that could be done but let the well blow until more fittings could be attached. After this blowing had continued for an hour, the drillers found that the 6-inch flow line had become red-hot for two feet at its end, due to the friction of the sand and shale on the pipe. This heat in turn set fire to the enormous stream of escaping gas.

Copyright, Keystone View Co.

This suit and cap are made of wrapping paper

Fire-fighting equipment was rushed to the scene, and the fire was deluged with steam, mud and water. This equipment included twenty boilers, twenty-one 3-inch lines, nine 4-inch lines, thirteen pumps and several large tanks. Finally, the fighters succeeded in extinguishing the fire to a height of 50 feet from the ground, but the gas still kept burning up above the effective zone of steam and water. The boilers could not maintain sufficient pressure long enough to keep the gas from the well from breaking through to the flame on top.

To face this fire and fight it effectively, the men had to use metal shields, otherwise it would have been impossible to bring the equipment within striking distance. At the same time these

Giant flame 200 feet in height, resulting from blazing oil well

men had to be sprayed with water from 3-inch lines, owing to the intense heat. Two U. S. Army officers who were present considered the advisability of using a 6-inch army field piece to snuff out the flame, but they concluded that the monster flame was too powerful for such a method to prove effective. The division superintendent suggested that dynamite be employed. His theory was that after the deluge of steam; mud and water had subdued the lower flames the concussion of the dynamite would interrupt the stream of gas long enough to permit the flames at the top to burn out before the intercepted stream of gas from the well could again reach them.

It seemed reasonable that this plan would work. In connection with the dynamite it was decided to use powerful streams of carbon tetrachloride, 100 barrels being provided for this purpose. The plan was accordingly put in operation. When the 150-pound charge of dynamite exploded, the brilliant flame suddenly changed to a deep red glow, then there came a tremendous big black puff and the fire was out.—By *Geo. F. Paul.*

A Wrapping-Paper Suit

WRAPPING paper is by no means an ideal material for wearing apparel. However, as a passing "stunt" a tailor of Brooklyn, N. Y., recently amused his friends and himself by cutting and pasting a complete garment of heavy wrapping paper, which is shown in the accompanying illustration. Even the cap is made of wrapping paper.

A New Type of Manufactured Fuel

A NEW type of fuel for which remarkable claims are made has been invented by Mr. Richard Bowen, of London, England, and a company has recently been formed to exploit the process. The new fuel is produced from coal slack and dust, lignite, peat, or other material, with a binder of pitch. The blocks are formed of a number of layers, which have the same effect as the laminations in ordinary large lumps of coal. The new fuel can be made in blocks of any desired size, and by combining various types of material it is stated that a product of any required calorific value within reason can be produced.

It is claimed that a good house or industrial coal can be produced from materials that could not hitherto be utilized for these purposes. Put briefly the inventor's claim is that out of what has so far been regarded as waste material reconstructed coal, in layers or laminations, just as it occurs in the earth, has been produced. The cost of laminated coal is said to be considerably below that of ordinary coal. We understand that licenses to work the process have already been acquired by a number of collieries in Great Britain and that negotiations are in progress with many others.

Snow-Melting Machine Used in Finnish Cities

AFTER ten years of experiment a Finnish engineer has invented a successful snow melter, manufactured by a machinery firm of Helsingfors. This machine is now used in Finland, Scandinavia, and Russia. It is also patented in Canada and the United States.

The melting capacity of the machine is 26 or more cubic yards per hour, depending upon the size of the machine

Deluge of mud, steam and water coming out of the well during the struggle to quench the flames

and the kind of fuel used. Cheap fuel, such as wood, coke, coal, kerosene and crude oil may be used. The smallest apparatus, weighing 500 pounds and requiring four men to keep it supplied with snow and fuel, uses, when fired with coke, 200 pounds of fuel and melts 32 cubic yards of snow per hour. The machine utilizes 90 per cent of the heat developed.

The apparatus consists of an iron furnace, water-jacketed all around; a snow receiver, or hopper, surrounding the upper part of the furnace; a system of ducts by means of which the water from the melting snow is again forced into the snow, thus increasing the melting; a high-pressure fan driven by a small electric motor for creating a strong artificial draft and driving the heat developed out through the snow. The cooling of the furnace walls is accomplished by leading the snow water through the water jacket from which it is forced out again through jets into the snow. The apparatus melts snow and ice. The dirt and gravel in the snow are automatically separated from the water.

Rear view of one of the locomotive headlights used in the Coliseum

Locomotive Headlights and the Republican Convention

LOCOMOTIVE headlights were brought into action for the purpose of securing motion pictures of the Republican Convention in the Coliseum, Chicago. These headlights were of an obsolete arc type, fitted with an improved type of parabolic reflector. Indeed, in testing the parabolic effect of one of these reflectors an engineer in charge of the installation burned a hole through a three-inch plank in four minutes, using the sun's rays for the purpose.

One of the improvised lamps appears in the illustration shown above. Each lamp is rated at 1,900,000 candle-power. The lamps at the convention were arranged in series of three, operating on 500 volts and drawing 32 amperes. No rheostat was necessary. The carbon electrodes, it will be noted, are automatically fed by means of the usual clutch and electromagnet arrangement.

The headlights were arranged about the balcony of the huge Coliseum in order to throw their powerful beams on the speaker's platform. A problem confronting the engineers was to diffuse the rays of light. This was solved by using specially wired heavy plate glass properly ground to break up the otherwise harsh beams. The battery of lamps made the large hall as bright as day.

The final stage in putting out the fire—separating the flame from the well

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

This hand truck permits one man to handle the largest cases without help

The One-Man Hand Truck

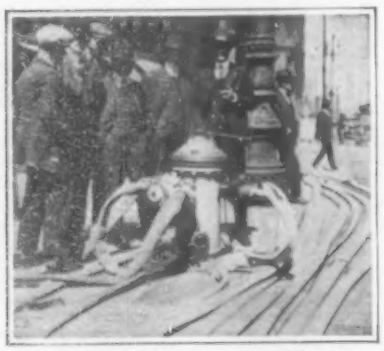
THE loading of the usual hand truck has left much to be desired, especially in these strenuous days of labor shortage and high wages. For it is a fact that in many instances the usual hand truck requires two or three men to load it, especially when bulky cases, barrels and so on are being handled.

It has remained for an ingenious American to develop a hand truck that is well within the definition of a one-man hand truck. This hand truck, which is illustrated in the accompanying view, is equipped with a special crate rest on wheel guards, the latter being provided with staggered steel pegs which may be adjusted to the vertical and the horizontal positions. To load this new hand truck, the operator takes hold of the case with the horizontal steel hook and then pulls back on the hand truck as shown.

The designer has also worked out other types of hand truck for handling barrels, bales and other articles with equal ease.

A Six-Fold Job for the Hydrant

BY means of a simple attachment it is now possible to convert the usual hydrant into several hydrants—not numerically, to be sure, but in point of application. In the accompanying illustration we notice a hydrant of the standard three-connection type, which, by means of three two-connection attachments, is made to serve six fire lines at once. The same two-connection attachment can be applied to single-connection hydrants or to any hydrant whose capacity is to be increased, always providing, of course, that there is sufficient water pressure to serve the additional lines.



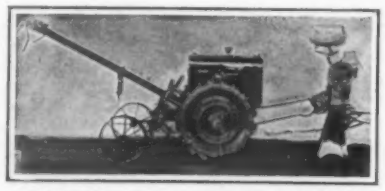
These simple attachments multiply the usefulness of the usual hydrant

New Method of Destroying Rubber-Tree Pests

IT is said that practically the only satisfactory method of exterminating the white ants which enter into and often destroy the roots of rubber trees is to fumigate them. There is a charcoal burning machine that generates fumes from a poisonous white ant powder, and forces them by means of an air pump into the holes made by the insects. If all the openings are then sealed with clay, the fumes will destroy the ants and their eggs in a few days.

The Gasoline Farm Laborer

THE scarcity of farm labor has had a marked effect on inventors. Indeed, during the last year or two unprecedented efforts have been made to develop compact, simple and inexpensive gasoline tractors for doing the work which heretofore called for considerable labor.



Driving the cream separator in the dairy

Of the many gasoline tractors developed for the lighter kinds of farm work, the model shown in the two accompanying illustrations may be considered typical. This little tractor, rated at a few horse-power, can be used for all kinds of light farming, including plowing, disking, cultivating, planting and so on. The same tractor can be attached to a special lawn-mower arrangement, as shown in the second view. A pulley on one side can be used for driving a butter churn, cream separator, grindstone and other odd jobs.

Using the Sun as a Stove

MAKING bread and roasting meat on the summit of Mount Whitney, Cal., in the absence of fuel, is possible by the use of a device invented by a scientist of the Smithsonian Institution, Washington, D. C. The intensity of the sun's rays is harnessed, the unused energy is capitalized, and food can be cooked beyond the line of perpetual snows.

An astronomical mirror at the Smithsonian Institution is capable of receiving and measuring the energy of sun rays, calculating that in summer the solar luminary transmits upon each acre of land energy equivalent to 7,500 horse-power. The use of the solar energy for mechanical purposes is no untried experiment, but the machinery devised by the Smithsonian Institution is a contribution to the future development of harnessing the idle energy from the sun.

The so-termed "solar cooker" consists of a half-cylinder of iron lined with mirror-glass which catches the rays of sun and concentrates them upon a metal tube that is the half-cylinder's axis. The tube contains oil which expands and becomes lighter by the heat as it passes through the tube. The latter is continued to form a loop outside the half-cylinder, thus making a sort of endless chain.

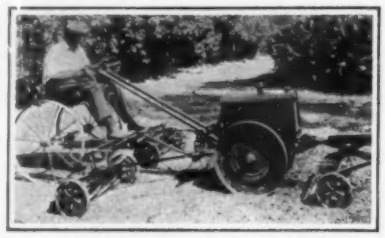
Passing through the loop, the oil cools. However, the sun's heat, forcing the oil through the portion of the tube inside the half-cylinder, compels the cooled oil to follow it, otherwise, there would be a vacuum. So while the sun shines there is a continuous circulation of oil. The "loop" passes through a box which contains an oven. Heat from the oil warms the oven and does the desired cooking.

A Discovery that Means Cheaper and Better Glass

IMPORTANT developments are eventually probable on the northern borders of Dartmoor, in Devonshire, England, reports the *Times Trade Supplement*, in consequence of the discovery near Okehampton of a very large deposit of granulite, a substance of much value in the manufacture of glass.

It is stated that an experimental furnace has been in use for some time, two others are being constructed, and it is anticipated that the commercial manufacture of glass will commence almost immediately. An initial difficulty, however, arises in the matter of securing adequate labor, no houses being available at present in the district; nevertheless the promoters consider the prospect excellent, as there is practically an unlimited supply of granulite at hand.

It is reported that it will be possible to manufacture glass bottles and jars cheaper than at any other place in the world. These anticipations are based apparently on an estimate of the cost of the material utilized on the spot amounting to only 15s. (at normal rate $3.65) per ton, compared with a cost of £2 ($9.73) per ton for the cheapest mixtures ordinarily used for making glass bottles.



Cutting the lawn with the gasoline tractor

Breathing from the Bottom Up

AMONG the first things that we learn from a good singing teacher is that we have been using about one-half or perhaps only one-third of our available lung capacity, leaving the balance untouched. The average person does not know anything about the bottom half of his lungs—he might as well not have any bottom half. If you tell him to take a deep breath, he starts, as usual, to fill his lungs from the top, and his deep breath is no deeper than his shallow one; it merely involves a lot of effort for substantially the same result. The trained singer or athlete, on the other hand, when about to indulge in a deep breath, builds up the mass of air in his lungs more or less like a pyramid. He starts at the bottom and works up; the central and upper regions of his lungs are not inflated until the bottom is blown up to the limit.

This little device soon determines what chance one has to become a professional singer

A New York singing teacher has invented a little device for recording lung capacity which emphasizes the difference between the right and the wrong ways of obtaining this capacity. Instead of interesting himself in the effects of expansion upon the subject's chest measure, he turns his attention to the waist, and measures the extent to which a filling of the lungs dilates this. More strictly, of course, this little instrument does not measure lung capacity itself, but rather the extent to which the full potential lung capacity is being utilized. Try it out yourself; if you did not know it before, you will be surprised to see how greatly you can distend your sub-diaphragm by drawing in all the air you can hold.

The One-Wheel Pedomotor of the Berliners

AND now it is the bicycle craze, so far as Berlin is concerned. Week by week more and more photographs come to us from the German capital, showing all sorts of bicycles and other pedomotors for carrying Berliners back and forth from home to business.

One of the latest types to come to our attention is the one-wheel device, which is shown in the accompanying illustration. This one-wheeled affair is similar to the trick devices employed by circus and vaudeville performers, and that being the case, is bound to be anything else but a comfortable means of travel. However, it appears that the Germans, among other things, are attempting to gain compactness in developing bicycling as a practical means of city travel, and that may account for the use of the one-wheel pedomotor.

One-wheel pedomotor in use on the streets of Berlin by a business man

BEFORE USING TARVIA
Washington Street, Milwaukee, Wis., before constructing roadway with "Tarvia-X."
AFTER USING TARVIA
The same street after "Tarvia-X" was used. Always smooth, mudless and dustless.
Tarvia

Tarvia

Preserves Roads–Prevents Dust

How the macadam streets of Milwaukee have been saved with Tarvia—

BEFORE the advent of the automobile, it had been a comparatively simple matter for Milwaukee to keep its miles of macadam residential streets suitably paved.

But with the coming of the automobile—and particularly the motor truck—the Department of Public Works began to have troubles.

Macadam streets that had heretofore been able to withstand traffic began to go to pieces quickly under the grinding, prying wheels of motor traffic.

The "Before" photograph of Washington Street above shows what happened. The maintenance problem became a most troublesome and costly one, for there are in Milwaukee more than 230 miles of these macadam streets.

How could this problem be met? How could Milwaukee keep these streets in good condition at low cost?

Milwaukee Found the Answer

The "After" photograph of Washington Street shows how the authorities met the situation—the very same situation that is facing road authorities and tax-payers in many cities and towns all over the country today.

They tarviated these macadam streets and avenues, making them smooth and firm and durable, and free from mud and dust.

They have *literally* transformed 1,700,000 square yards of these old macadam streets with an inexpensive Tarvia surfacing.

Is your problem like Milwaukee's? Do you want good, durable thoroughfares at low cost? Then why not take advantage of Milwaukee's experience and adopt Tarvia? It is ideal for city boulevards, residential streets and for state and county highways. No mud; no dust; no sprinkling; always smooth and firm and clean and waterproof.

Tarvia Roads Cost Less

"But do not such roads cost more?" you may ask.

No. Tarvia roads cost *less*, because the use of Tarvia reduces the annual up-keep expense to such an extent that it more than pays for the cost of the treatment.

In fact, many cities and towns have settled down to a regular policy of building Tarvia roadways wherever they are appropriate, *because Tarvia saves money for them.*

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

New York, Cincinnati, Minneapolis, Atlanta, Lebanon, Latrobe, Chicago, Pittsburgh, Dallas, Duluth, Youngstown, Bethlehem, Philadelphia, Detroit, Nashville, Salt Lake City, Milwaukee, Elizabeth

The Barrett Company

Boston, New Orleans, Syracuse, Bangor, Toledo, Buffalo, St. Louis, Birmingham, Seattle, Washington, Columbus, Baltimore, Cleveland, Kansas City, Peoria, Johnstown, Richmond

THE BARRETT COMPANY LIMITED: Montreal, Toronto, Winnipeg, Vancouver, St. John, N.B., Halifax, N.S., Sydney, N.S.

Recently Patented Inventions

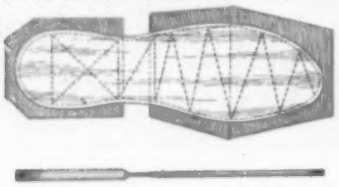
Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Electrical Devices

TELEPHONE CORD.—A. RHEINO, 100 Oregon Road, East Toledo, Ohio. The object of the invention is to provide mechanism for use in connection with the usual cords connecting the receiver to the stand, for preventing twisting of the cord, and for prolonging the life thereof and preventing breaking of the transmission wires.

Of General Interest

INSOLE.—J. BERGSTEN, 1324 Edwards Ave., Bronx, N. Y. The object of the invention is to provide an insole made of reinforced fibrous material, which is exceedingly light, to be inserted in shoes, and other footwear, and ar-



A PLAN VIEW, PARTLY FINISHED, AND EDGE

ranged to keep the feet of the user warm and dry. Another object is to provide an insole which is naturally resilient, thus insuring easy walking. Another object is to utilize the heretofore wasted bark of the balsa tree in the formation of the insole.

REVERSIBLE TOOTHBRUSH. — D. G. WHITE, Room 402, 500 5th Ave., New York, N. Y. The object of the invention is to provide a construction in which the brushing means may be adjusted to conform to the interior and exterior contour of a person's teeth. Another object is the provision in a toothbrush of a body carrying the bristles formed of flexible material capable of being fitted over a holder of different shapes so as to present different curves to the bank of bristles.

AUTOCLAVE TRAY FOR COOKING GLUE. —L. MAUERHOFER, 120 Rue Blomet, Paris, France. This invention has for its object an autoclave tray employed in the preparation and cooking of glue. It is essentially characterized by perforated plates located above each other and enabling the heating system arising from the lower part of the autoclave, to attach the glue at the central part of the plates and at the peripheral part.

SHIP'S POSITION PLOTTING CHART.—F. E. UTTMARK, 8 State St., New York, N. Y. Among the principal objects which the present invention has in view are to enable a navigating officer to find his position from observations, to manipulate the navigating chart with despatch and relative ease, to avoid the use of a number of large charts such as are now generally used, and to simplify the operation of plotting the ship's position when using the Sumner lines.

DEVICE FOR MECHANICALLY AIDING THE HAND IN WRITING.—W. J. HENRY, 868 Kenyon St., Akron, Ohio. The invention particularly relates to pen holding and hand guiding devices for use in teaching proper penmanship in schools and like places. The device comprises a wrist encircling element including a securing strap and a band connected at spaced points to the strap, a pen engaging element and a hand guide, one end of which supports the pen engaging element and the opposite end extending between the band and strap of the wrist encircling element, and is frictionally held adjustable.

KETTLE.—A. T. TIMOSCI, 668 Willis Ave., N. E., San Jose, Cal. The invention has for its object to provide a kettle adapted for heating water, with fuel of any character, wherein the kettle is so arranged that the water will be quickly and thoroughly heated with a minimum amount of fuel. The kettle is provided with a false bottom, or partition, the water below the partition heats first and moves inward, passing up at the center of the kettle. The cool water dropping down at the sides and flows inwardly along the top of the partition to greater heat.

LEAFLESS PHOTOGRAPH ALBUM.—P. H. KRAETSCH, Astoria, Oregon. The invention has for its object to provide a device of the character specified, adapted for containing mounted photographs, wherein a container is provided for the photographs in the form of a tray arranged to retain the photographs in flat extended position and to permit them to be easily inspected, the cover forming a support for the photographs as they are removed for inspection.

PLANT STAND.—D. F. LOUDON, 109 W. 102nd St., New York, N. Y. The object of the invention is to provide a plant stand more especially designed for use in the home and arranged for holding potted plants in a manner which gives the proper angular position relative to the sunlight to insure uniform growth and development of the plant in every direction. Another object is to enable the user to readily adjust the plant stand for accommodating pots of different sizes.

BREAD PAN.—S. GOODFRIEND, 106 Elm St., Yonkers, N. Y. Among the principal objects of the invention are to form a rivetless utensil of the character mentioned, to unite for service a plurality of pans with a supporting structure inseparably mounted therein, to separably unite the pans and supporting side rails therefor, to prevent separation of the pans and the uniting structure, and to provide the united pans with a small edge rim.

PORTABLE HYGROSCOPE.—C. SAMPIETRO, 456 Bradford St., Brooklyn, N. Y. This invention relates generally to a hygroscope or weather indicator, and more especially to a portable device which may be conveniently carried upon the person without occupying a great amount of space. The device is of simple and compact construction and may be readily attached to a pencil, pen or any other desired article.

EYE SHIELD.—F. BERGMANN, 15 Cours Eugenie, Lyons, France. The invention has for an object the provision of a construction made of transparent material, which may be quickly and easily applied and removed. The shield comprises a pair of reinforcing strips of fab-

A SIDE VIEW SHOWING THE INVENTION IN USE

ric, a plurality of lines of stitching extending through the fabric and body for holding the strips in place, tying strips and lines of stitching for holding the tying strips in place.

INSCRIPTION PRINTING ATTACHMENT FOR CAMERAS.—S. G. ZUCKERMAN, Sulphur, Okla. Among the objects of the invention are to provide means for transferring an inscription to a photographic film to be developed with the remainder of the negative, the reproduction of which on photographic prints will resemble in character that of pencil or ink or white or light paper.

SIPHON STARTER.—A. H. MARHENKE, 216 W. 16th St., New York, N. Y. The particular object of the invention is to provide means to start a siphon so as to empty a tank that is located in an elevated position or otherwise difficult of access for starting a siphon by ordinary means, the device being such that the short leg of the siphon may be projected directly into the water and then by a simple manipulation the water will be carried up the short leg and over the bend sufficiently filling the siphon to initiate the flow of the water from the tank.

SUBMARINE VESSEL.—G. DORFFEL, 2141 S. W. 47th Ave., W. Seattle, Wash. The invention has reference more particularly to a submarine mother vessel in combination with a secondary, or plurality, or offensive submarines, and means whereby the submarines can be transported by the mother vessel. An object is to provide a submarine vessel of great cruising radius, having a high factor of safety and by means of which great areas of sea can be covered for offensive military purposes.

SHOE CLEANER.—R. J. CRAIG, 6 Oakwood Ave., Orange, N. J. An object of the invention is to provide a shoe cleaner having a receptacle into which the clearing powder may be inserted from time to time, and which may be effectually closed so that the device will be free from powder on its exterior and can be readily carried in a suitcase without danger of injury to other articles. A felt pad is provided at one end with means for enabling the powder to feed through in quantities desirable for the cleaning operation.

AUTOMATIC AIR VENT.—P. CARROLL, 11 Davis St., Long Island City, N. Y. The invention relates to house plumbing devices. Among the objects is to provide a device which will serve to prevent siphonage without the employment of a continuous vent pipe. Another object is to provide an attachment for a trap which may be attached at any time either during construction of the building or later without marring the building, the device will not collect water of condensation and therefore will never freeze.

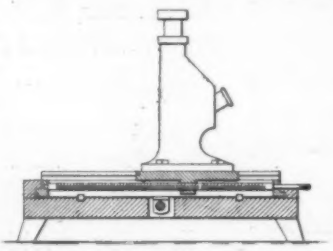
SYSTEM OF IRRIGATION PIPES.—G. W. RICE, Pacific Hotel, Boise, Idaho. The invention relates to connections and attachments to irrigating pipes designed to be used in distributing water from either side of a ditch to corrugations in the land, and has for its object to produce a simple and efficient means for securing the desired result and one in which the land may be irrigated and the flow regulated as to quantity and locality of distribution.

SAFETY TELLER'S WINDOW.—C. POVEY, 157 5th Ave., Astoria, L. I., N. Y. The invention has particular reference to the construction of windows for bank tellers and similar officials who are chargeable with the handling and safe keeping of large amounts of cash or other valuables. Among the objects is to provide a grille having a plurality of series of rigidly fixed bars made preferably of bullet proof metal, and beneath the grille a movable transfer device large enough to receive a pass book with money or checks.

Hardware and Tools

PADLOCK.—P. MALACZYNSKI, 1077 Manhattan Ave., Brooklyn, N. Y. This invention particularly relates to a combination padlock and has for an object to provide a construction which is extremely simple, but which requires a very accurate adjustment of the parts to produce an unlocking operation. Another object is to produce a combination wherein means are provided which require two separate adjustments to completely lock or unlock the device.

JACK CENTERING DEVICE.—J. A. GARCIA, c/o Serling Eng. Co., 200 William St., New York, N. Y. The invention has for its object to provide a construction wherein a jack of any desired type may be positioned approximately in the right place and then adjusted to the exact position for operation in the usual manner. Another object is to pro-



A LONGITUDINAL VERTICAL SECTION THROUGH THE CENTERING DEVICE

vide a centering and moving device wherein the jack may be used to raise a piece of machinery or other article and then move the object laterally a short distince.

Heating and Lighting

FIRE BASKET.—B. M. WARD and H. G. SMITH, Box 414, Fayetteville, N. C. The invention aims primarily to provide a fire basket which may be readily assembled and knocked down. A further object is to provide a device which may be applied to any hearth and removed thereupon without the aid of any mechanics, and which conforms generally to the contour of the conventional hearth.

Machines and Mechanical Devices

DUST AND LINT COLLECTING SYSTEM. —S. J. B. WHITED, Shreveport, La. An object of this invention is to provide a system for collecting lint which will obviate the necessity of much labor, and which will at the same time render the lint more valuable in that it is collected free from dust and grease. A further object is to provide a system for use primarily with linter machines in cotton seed oil mills, thus dispensing with the necessity of condensers.

PISTON RING ADJUSTER.—R. HAMMERLY, 125 77th St., Union Course, L. I., N. Y. The object of the invention is to provide a piston ring adjuster which may be used to hold and compress a piston ring into position in a groove in a piston, the adjuster having a flexible member which slightly compresses the piston ring to hold the latter until it is desired to compress the ring further when the lever on the adjuster operates in connection with the flexible member to compress the piston ring in the groove of a piston so that it may enter the cylinder.

RIVET GUN RIG.—W. B. ASHE and F. C. BIVINS, 321 Newport News Ave., Hampton, Va. The invention relates more particularly to devices used in riveting plates and framing of steel vessels. An important object of the invention is to hold the necessary tools at or near the location of the rivet, thus enabling the operator to drive and chip the rivets with the machine suspended and supported so that he can shift from one to the other without laying them down, to fall or be knocked off the staging.

GREASE CUP.—C. C. HAMILTON and J. HUTCHINSON, Box 80, Gull Lake, Saskatchewan, Canada. The invention has particular reference to that type of cup using a grease of viscol consistency, and which usually consists of a body portion or base and a cap threaded on the same, the objects are to provide means for preventing retrograde movement of the cup through constant vibration, and holding the cup in any set position.

BORING BAR.—J. R. MARTIN, 299 State St., Brooklyn, N. Y. The invention relates to metal working machines. The object is to provide a boring bar with a plurality of cutters disposed circumferentially to insure accurate boring throughout the length of the bore and to permit of making a large cut at a time. Another object is to permit quick and accurate adjustment and convenient attachment of the boring head to the usual bar of a lathe or boring machine.

CHRONOMETER ESCAPEMENT.—S. TIDEMAN, Fairhope, Ala. The object of the invention is to provide a chronometer escapement arranged to prevent interference with the free oscillating movement of the balance wheel by the action of the driving train of gear wheels connected with the escapement wheel. Another object is to impart the impulse to the balance wheel at the rim thereof thus relieving the pivot of undue strain and thereby reducing friction. Another object is to govern the force of the impulse given to the balance wheel to insure a definite speed of motion.

PUMP JACK.—A. S. D. FRENCH, Box 61, Bixby, Okla. This invention more particularly relates to that type of pump jack including a normally stationary frame and a rocker mounted to oscillate thereon. An important object of the invention is to provide a pump jack with adjustable bearings whereby the pump jack may be adjusted to the varying conditions met with in different wells, and whereby the stroke may be varied as desired.

DRILL.—F. R. WEATHERSBY, Office of City Attorney, Houston, Texas. This invention has for its object to provide a simple, inexpensive, firm and rigid method of connecting drill bits to the shank, in such manner that they will not become detached, and the securing means will not be in a position to be injured or broken in operation of the drill.

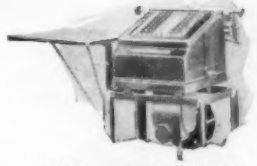
CYLINDER GRINDING ATTACMENT FOR LATHES.—W. T. SNELL, 312 Chihuahua St., El Paso, Texas. The invention has for its object to provide mechanism in connection with a cylinder grinder for permitting the grinding shaft to be set at an angle to the driving shaft, to provide for grinding cylinders of various sizes, and to provide mechanism in connection with the ball bearing mounting of the shaft for compensating for wear.

TESTING MACHINE.—W. J. FRANCKE, 262 Lincoln Ave., New Brunswick, N. J. The object is to provide a testing machine more especially designed for testing the quality of metals by determining the deformation that takes place in their crystalline structure while under flexure strain by measuring the deflection. Another object is to cause the deflection, which is normally slow, to take place rapidly

(*Continued on page 712*)

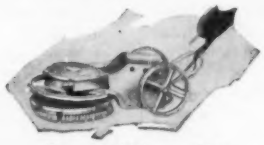
The modern hotel is but one example of better service made possible through intelligent application of electrically driven appliances

Massage Vibrator equipped with G-E motor

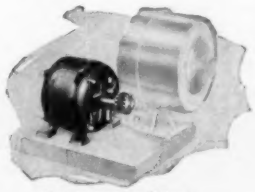


Adding machine equipped with ⅛ H. P. motor

Dishwasher equipped with ¼ H. P. motor



Floor scrubbing machine, ¼ H. P. motor encased



Knife cleaner driven by ¼ H. P. motor

Look for this mark of leadership in electrical development and manufacture

Speeding Up Service with G-E Motors

IN the big hotel kitchen, the chef and his assistants press a few buttons. A food chopper here, a potato peeler over there, a mayonnaise mixer, a coffee grinder and an ice-cream freezer, all begin to whirr merrily. Everything runs like clockwork, for the public must be served, and with G-E Motors on the job service is simple.

It's the same way upstairs, where electric scrubbing machines and floor polishers keep halls and corridors spotless and shining. Or down in the barber shop, where electric vibrators and warm air blowers help to groom Mr. Business Man. And in the hotel office electric adding and billing machines make accounting quicker and more accurate.

Without G-E Motors this work would be done, for hand or foot power would operate the same machines. But that would mean slower service, more servants, harder work. So the General Electric Company, in building and applying small motors to small tools and machines, have broadened the usefulness of these labor savers, and at the same time have established the fact that there are hundreds of other machines for various kinds of work which may profitably be motorized.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

G-E motors

From the Mightiest to the Tiniest

GBS

GENERAL ELECTRIC COMPANY

RECENTLY PATENTED INVENTIONS

(Continued from page 710)

so that readings may be taken when the deflection is complete thus eliminating the errors in reading which are caused by the influence of elastic after effect.

SAWING MACHINE.—J. H. McPARTLAND, 105-107 Water St., St. John, N. B. Canada. The invention relates to portable sawing machines adapted to be employed in felling trees and cutting the same into cord or stove lengths. The frame is mounted for varying the position of the saw for cutting the tree close to the ground or at a distance as conditions may require; an axle is provided to receive wheels or sled runners with the wheels slightly off the ground. The machine may be driven by a gasolene motor or in any suitable manner.

WORM DRIVE.—G. DORFFEL, 2141 S. W. 47th Ave., W. Seattle, Wash. The object of the invention is to provide driving mechanism whereby worms and worm wheels may be used and at the same time a high speed secured. Another object is the provision of a worm provided with compensating connecting means whereby the driving mechanism may operate under momentum notwithstanding the use of worms. A further object is the provision of a drive arranged to secure high speed provided with means for connecting power for hand operated propelling mechanism.

Musical Devices

PHONOGRAPH RECORD HOLDER.—W. H. SCHLINGLOFF, 345 Forest St., Jersey City, N. J. An object of the invention is to construct a device which is capable of attachment to any type of cabinet to convert the same into a record holding cabinet. A further object is to provide a device in such a manner that the entire holder is capable of being swung within the cabinet when not in use, and swinging clear of the cabinet when it is desired to remove the records.

VIBRATORY DISK.—P. LACHMAN and G. THOMAS, 124 Grand St., Rahway, N. J. The invention has reference to musical instruments wherein a vibratory disk or diaphragm is used and relates more particularly to the disk and its mounting. An object is to provide means whereby the vibration of the disk or diaphragm of a talking machine can be readily controlled and regulated.

RECORD INDEX ENVELOPE.—J. ZIMMERMAN, 4 Tesla Place, Brooklyn, N. Y. The invention refers particularly to means for locating phonograph disk records. The primary purpose is to provide an easy, cheap and reliable method for indexing or identifying the several disk record jackets or envelopes by the use of an initial letter corresponding to the name of the musical selection carried by the disk.

Prime Movers and Their Accessories

IGNITION DEVICE.—J. S. COYLE, 336 Universal Club Bldg., Grand and Washington Aves., St. Louis, Mo. The present invention relates to ignition devices for internal combustion engines, and pertains more particularly to spark plugs therefor. The primary object is to provide means for constantly cleaning the electrodes of a spark plug. A further object is to construct a device in which the cleaning operation is automatically carried out by the operation of the motor piston.

Railways and Their Accessories

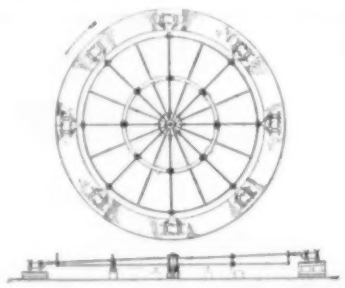
VACUUM RAILWAY.—R. B. DAVY, Hayward, Cal. An object of the invention is to provide a railway, comprising a tube with stations at intervals, the tube between stations having a partial vacuum produced therein so that suitably propelled cars moving therein may travel with greater speed by reason of the lessening of the air resistance. A further object is to provide an arrangement in the stations whereby the car has egress and ingress to the adjacent vacuum tube portions, without admitting enough air to the tube portions to destroy the vacuum.

Pertaining to Recreation

CABINET FOR AN EXERCISING APPARATUS.—J. J. COOPER, Stamford, Conn. The object of the invention is to provide a cabinet for exercising apparatus arranged to permit the user to conveniently enter or move out of the same. Another object is to permit of readily disassembling the parts and to fold the same with a view to take up very little room. Another object is to render the cabinet exceedingly tight to confine the vapor or steam. Another object is to confine the user's body, except his head, within the cabinet and to allow the user to control the heat within the cabinet.

BLOCK TOY BUILDING.—O. W. WARD, Room 52-196 5th Ave., New York, N. Y. The invention relates to toy building constructions and has particular reference to devices of this kind being calculated to afford a vast amount of information of a practical nature for boys and girls, as well as affording endless amusement in the erection of building structures. A child may erect buildings of different designs or sizes, the building units having means for interlocking different elements together.

PLEASURE MACHINE.—H. WILKENS, 620 34th St., Norfolk, Va. The invention relates to amusement devices such as are commonly operated at seaside or other amusement resorts. More especially the invention comprises a frame structure rotatable around a



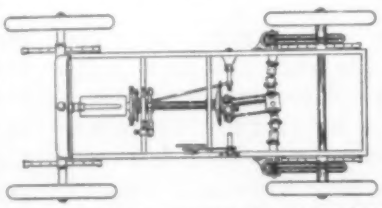
A PLAIN VIEW AND VERTICAL TRANSVERSE SECTION

vertical axis and within and above a stationary annular trackway and having associated with the rotatable frame a number of carriers for passengers movably supported upon the trackway and caused to be actuated there over by means that causes the rotation of the frame work.

Pertaining to Vehicles

DANGER SIGNAL FOR AUTOMOBILES.—J. SCHACHT, 1498 3rd Ave., New York, N. Y. An object of the invention is to provide a signal that may be readily seen by persons either in front of or behind the vehicle carrying the signal, and which may be projected either by hand or foot means and locked in projected position leaving the operator's hands free for the control of the steering or driving mechanism; means are also provided for the automatic return of the signal to normal secluded position.

POWER TRANSMISSION.—G. L. JACQUES, Neillsville, Wis. This invention relates generally to transmission of power and more particularly to a power transmission for motor vehicles, the primary object being a power transmission which will enable the changing of



A TOP PLAN VIEW, SHOWING FLEXIBLE SHAFT, DRIVING DISK, AND PROPELLER SHAFT

speed without breaking the power connection between the motor and the drive wheels. A further object is the provision of a friction power transmission in which greater bearing is provided and maintained between the driving and driven friction members.

Designs

DESIGN FOR A PINCUSHION.—CECILE LAFITTE, 857 Forest Ave., Brooklyn, N. Y.

DESIGN FOR NEWSPAPER VENDING CABINET.—O. J. HOTALING, 23 Melrose Ave., East Orange, N. J.

DESIGN FOR A COVERED DISH.—E. J. JOHNSON, 46 W. Broadway, New York, N. Y.

DESIGN FOR A GAME BOARD.—J. F. TOOHEY, Box 505, Troy, N. Y.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject-matter involved, or of the specialized, technical or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

MUNN & CO., Patent Attorneys.
233 Broadway, New York, N. Y.

Branch Offices: 625 F Street, Washington, D. C.
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Wireless Half Way 'Round the World

(Continued from page 698)

a length of about ten feet with a mechanical ultimate strength of over 15 tons and an electrical flash-over voltage when dry of about 190,000 volts at a frequency of 50,000 cycles.

The largest station previously constructed by the Navy is the one at Annapolis, Maryland, which can deliver a maximum output of 168,000 ampere-feet, whereas the Lafayette station should be capable of delivering 330,000 ampere-feet, with more on overload. The maximum wave-length of the Lafayette station will be about 23,000 meters.

From these facts it is evident that the Lafayette station, and it is quite appropriately named, will be practically twice as powerful as any radio station now in existence. It will be capable of transmitting messages approximately 12,500 miles or half way around the world.

France has a colony at Noumea, New Caledonia, which is just about half way around the world from Bordeaux. Messages from Bordeaux will reach New Caledonia from both directions, which will probably develop some interesting scientific data.

The present plan is for the Lafayette station to transmit at the rate of 50 words per minute, or 72,000 words per day. Sending messages at such a high speed by hand continuously is out of the question, so the signaling will be done by a mechanical device through which a narrow tape is run bearing the dots and dashes previously perforated by a special kind of typewriter made expressly for the purpose. There are few radio receiving operators who can handle incoming messages at this speed for hours at a time, no matter how expert they are, and to meet this contingency, as well as to guard against errors, it is said that the French intend to equip their stations throughout the world with mechanical receiving apparatus that will make phonographic records of incoming messages. These records may afterwards be "played" over more slowly and transcribed.

Practically all of the great nations now have powerful transoceanic radio plants. Norway has, at Ulienhaug near Stavanger, a transmitting station using tape sending machines. There are ten 400 foot-masts in pairs holding an antenna of 24 wires. The power is 300 kilowatts, and the normal sending wave is approximately 10,000 meters. This station sends to America, while its mate, at Naerland, 20 miles south, does the receiving, using the phonographic roll method. Its antenna is held by 8 iron masts 300 feet in height.

The Lyons radio station, the largest French station previous to the construction of the Lafayette station, uses apparatus originally intended for a plant in Indo-China. Eight towers, six of which are 590 feet high and two 787 feet high, carry an antenna in a sheet 2,952 feet long by 492 feet wide. The wave-carrying capacity of Lyons is approximately 6,210 miles on a power of 150 kilowatts. It is reported that Shanghai papers get their daily news from the Lyons station, and that messages from this station have been heard distinctly at Guam, in the Ladrone Islands, 7,452 miles distant.

Back in 1913 there were 560,000 cablegrams handled between the United States and Japan. This number jumped to over 3,000,000 in 1917 and touched the 5,000,000 mark the following year. It is reported the Japanese are constructing a very powerful radio station in northern Japan for commercial use. At present their navy radio plant close to Funabashi is giving a few hours daily to transpacific radiograms most of which are sent to Hawaii for further relay to the United States. Funabashi is powerful enough, however, to work direct with San Francisco when atmospheric conditions are favorable. The normal working wave of this big plant is about 7,000 meters. The station compound takes up about 4 acres of ground. A triangular pillar 787 feet in height is in the center, and ranged in a circle around it at a radius of close to 360 feet are 16 secondary square pillars 196 feet high. The antenna wires radiate from the central tower to the secondary pillars like the ribs of a colossal umbrella.

In the United States the Naval Radio Station at Annapolis, Maryland, is probably the most powerful. Its four towers form a square and they are 620 feet in height. The radius of action is normally 6,500 miles under a power of 500 kilowatts.

Germany has two big radio stations, Nauen and Eilvese. Great Britain has a monster plant at Carnavon, Wales. Italy can radio to America from Coltano, and Spain has apparatus by no means tiny at Aranjuez which is worked through a distant control wire at Madrid. These facts and figures serve merely to give a general idea of the radio system of the world and to emphasize the magnitude of the Lafayette station.

Our Army and Navy will leave many monuments in France as a record of our participation in the World War. Among these monuments the Lafayette Radio Station will be one of the most striking and useful.

"Maryland" Our First 16-Inch-Gun Battleship

(Continued from page 699)

for revolving gun turrets, air compressors and many other devices making the "Maryland" an electric ship indeed.

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We give below, in chronological order, the various steps in the evolution of the electric drive in the United States:

1907.—First application of the principle adapted to fire boats of the city of Chicago.

1912.—U. S. S. Collier "Jupiter," first naval vessel of any nation equipped for electric drive launched at Mare Island Navy Yard, San Francisco, after design of Dr. W. L. Emmet of General Electric Company.

1917 (April).—Emmet's principles applied to U. S. S. "New Mexico," built and launched at New York Navy Yard.

1919.—U. S. S. "Tennessee," launched at New York Navy Yard. Navy Department adopts electric drive for six new battle-cruisers to have a speed of 33¼ knots and develop 180,000 hp. each.

1919 (October).—Fishing trawler of 100 tons equipped with electric drive, the first installation of its kind to vessels of this cass.

1919 (November).—Launching of U. S. S. "California" at Mare Island.

1920 (March).—U. S. S. "Maryland," launched at Newport News, Va.

Turning the Wheels of a Century Hence—I

(Continued from page 700)

put vast quantities of heat away to use when we need it. And the pitiful part of it all is that perhaps the greatest untouched source of power of them all, the power inherent in the atom and the molecule, which we know to be there, know to be enormous and to be ready stored for our use, we don't know how to get out.

One of the reasons we do not use some of the available natural powers—tide and waves, wind and earth's heat—is the fact that the fluctuation between their normal and their maximum is so great. There is nothing impossible from an engineering standpoint in the proposition to erect a thousand huge windmills and use them to generate electricity, all the generators connected in one line which would thus take care of the fluctuations of wind in one locality by the average wind velocity over a wide area. But who

(Continued on page 714)

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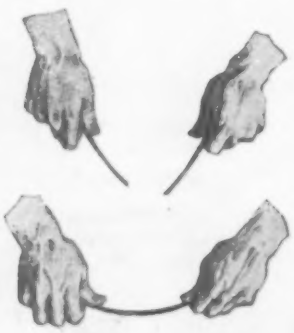

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Turning the Wheels of a Century Hence—I

(*Continued from page 712*)

is to say what is the maximum velocity of the possible wind? Shall we make our windmills strong enough to withstand one hundred miles an hour? Then they would be vastly heavy for lighter breezes to move. Shall they stop at fifty miles an hour? Then what will protect them when the wind goes to the hundred and fifty miles of the tornado?

Never the structure raised by man but the sea has wrecked when it would. Never the vessel made by man but the sea could smash if it would. Who shall make a tide motor on the Bay of Fundy for the normal twenty-foot tide which will withstand a thirty- or forty-foot tide, a typhoon or a water spout?

There are volcanoes with lakes of molten lava which are tame by the year together. Yet if you had a fortune, gentle reader, would you put it in a vast plant to use that natural heat, and risk the rise in lava level or the possible eruption which has wrecked and buried more than one city, of which Pompeii is but the classic example?

There is an untold wealth of electrical power in the atmosphere; any thunder storm shows that. But since Franklin brought down a spark with a kite and key, who has tried to harness that power? We do not because we do not dare.

Remains the beneficent power of the sun and the power of gravity as made manifest in our water wheels. Sun power will undoubtedly, some day, be a great asset, but it will be when man learns to transform heat directly into electricity without passing the power of heat into compressed water vapor, through the mechanics of a steam engine, the revolution of a generator. Invent you the device which will take sunshine in at the top and give off current at the bottom and you will produce a panic in Standard Oil shares and ruin the coal industry, the while you benefit a power-starved world. But until that day comes, or some genius arises who can make a solar-heat engine more cheaply and more efficiently than a coal or oil engine, or until some man arises who will be a Moses to those who struggle in the darkness looking for a way to store electrical power, the sun motor bids fair to remain what it is now—a curiosity, a potentiality, a hope, a dream of the future.

So we find that water power, gravity power, is the hope of the world when its fuels are exhausted. Though this exhaustion is by no means immediate, cheap coal can be in the markets but a few years more, probably less than a century; and the oils—well, there are those who say they are no longer cheap.

Water power—"white coal" as the French picturesquely and poetically call it—is to mean more and more to the world as its coal and oil become dearer and dearer. That we of this country, with enormous resources of "white coal" power, be not behind in its development, and that, as a first step, he who has thought little or nothing of the subject may be led to think, and thinking, act, is the hope and the purpose of this and the succeeding articles in this series.

The Silent Teacher

(*Continued from page 702*)

one is often combined with as many as twenty or even thirty transparent plates.

Interspersed with the animated drawings are titles; and, when necessary, a pointer is introduced to draw attention to something that is to be emphasized. Up to the present time, a fairly complete library of scientific subjects has been prepared. Even text books are being "animated" by this process. Within a comparatively short time, as educational developments are reckoned, it is certain that catalogues and libraries of pedagogical films will spring into being and vie with our public book libraries. Then it will be a simple matter for a school to order a series of films on any subjects desired. These will of course be returned within a few days, as entire courses of study can be clearly outlined to students by the motion picture method in a very short time.

Furthermore, subjects formerly taught in colleges are now made understandable for children of ten. And it is now possible for the man-in-the-street to fill in many gaps in his incomplete education by seeing the animated technical drawing in the regular motion picture theaters. In passing, I may say that a well-known motion picture man who has just returned from England reported that he heard some photoplay theater patrons ask the cashier of a London theater what animated drawing was being shown. They came to see the educational picture, and were not interested in the feature story.

The type of work now being done to simplify educational methods may be seen from the following descriptions of a few animated technical drawings.

"The Pitcher Plant," a botanical subject, is an illuminative study of a plant that eats animals. In the animated technical drawing, the plant is first shown in a state of nature with insects flying about it. Then a cross-section is flashed on the screen showing the interior of the plant lined with bristles that point downward. The cavity at the bottom of the plant is filled with water from the rain, and at the brim of the chalice a sweet sticky fluid is deposited by the plant. Evidently the plant understands the habits of the bug, for when an insect alights on the plant, it walks down the bristles to feed on the sugary substance at the margin of the chalice. Then the insect turns and tries to walk back. A close, enlarged view shows the futile attempt of the insect to butt through the downward pointing bristles. It cannot fly out because insects do not fly in vertical lines; and every attempt to fly in an upward diagonal results in the insect's striking against the side of the plant. Overcome with exhaustion, the insect falls into the water and is gradually absorbed by the plant.

In the field of practical science, the manner in which wireless telephony is pictorialized is extremely interesting and instructive. The picture begins with an analogy between sound and electric waves and the ripples made by a stone thrown into a pond. Then a title discloses the information that sound, as we know it, travels through the air, its transmission depending upon particles of matter striking against adjoining particles. The radiation of sound waves from a striking electric bell illustrates this principle. The next step in the explanation points out the fact that each particle of matter is surrounded by space, and the space itself is filled with something that we call the ether. Wireless travels through the ether. Now an antenna is substituted for the electric bell and zig-zag flashes are seen to shoot from it through the ether. A comparison of sound and electric waves is shown by picturing a boy shouting and showing the comparatively short distance his voice will carry. A title then says that high frequency electric waves will cross the ocean.

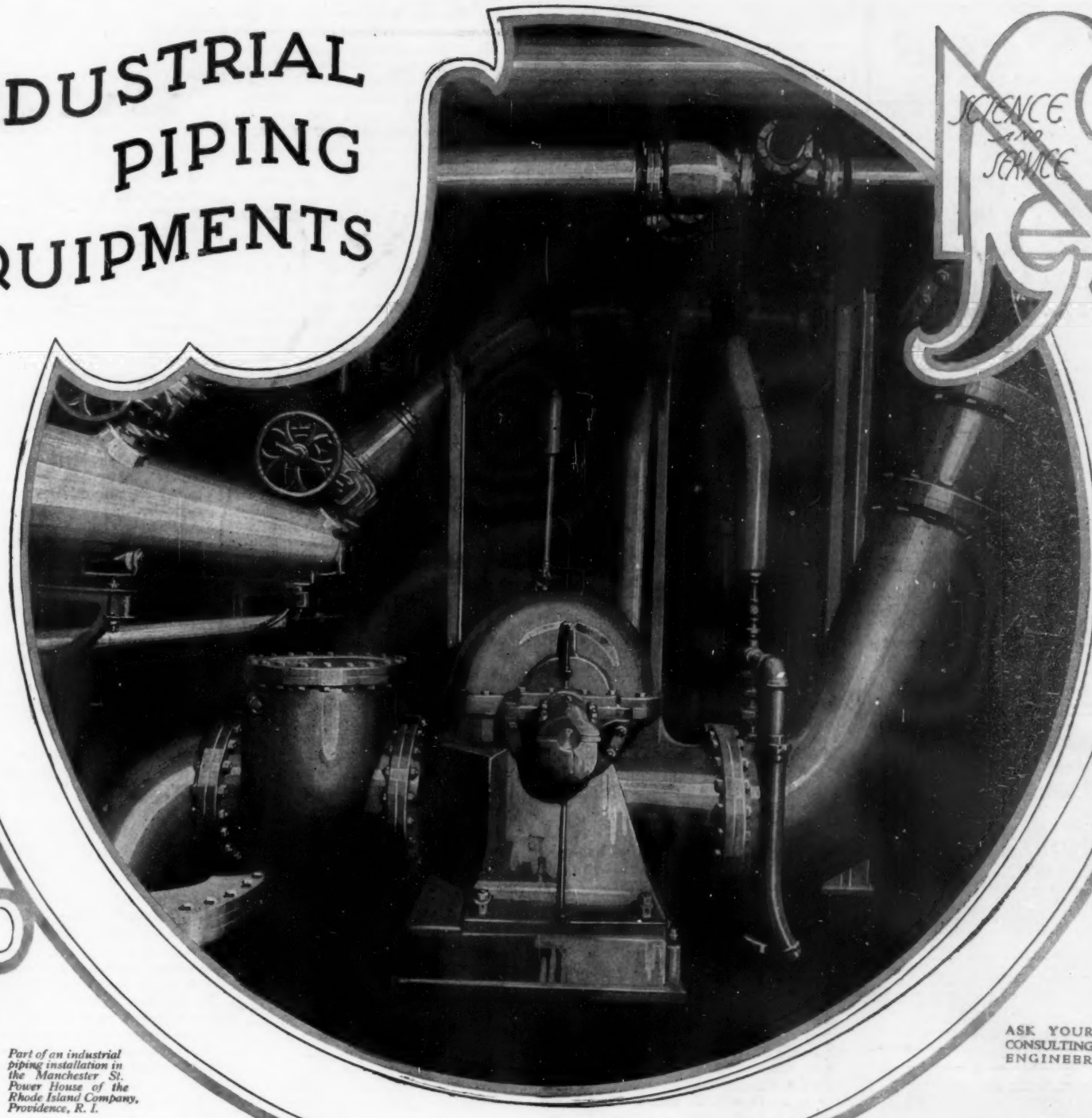
The explanation of how the voice "rides" the electric "carrier" wave is shown in the following way: A water-pump diagram with valves is thrown on the screen and the uniform vibrations of the diaphragm are revealed. Then the valve is opened and closed at irregular intervals to show that the flow of water is modulated by the valve. A title then makes the suggestion:

"Suppose the valve to be operated by voice vibrations."

Now a wireless telephone transmitter is flashed on the screen with a man talking in front of it. The modulations of his voice, transmitted faithfully to the dia-

(*Continued on page 716*)

INDUSTRIAL PIPING EQUIPMENTS



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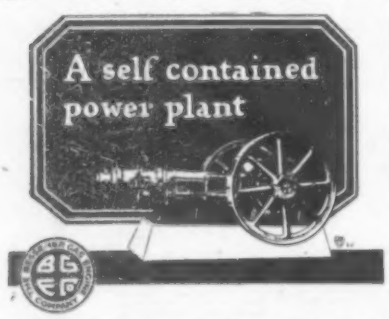

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The Silent Teacher

(Continued from page 714)

phragm, are shown by vibrating dashes to represent the sound waves. Dissolving the valve into a vacuum tube amplifier, and replacing the piston of the water pump with an oscillating current generator, a steady flow of current is flashed on the screen and the objective figure diagram metamorphosed into a skeleton wireless telephone diagram.

The form of both voice and electric waves are then shown, so that they appear in combination. The electric wave is modulated by the voice wave. But at the receiving end of the wireless telephone system, the wave combination is halved. That is to say, the electric "carrier" waves are eliminated and the sound waves are heard.

Even astronomical phenomena have been portrayed by the animated technical drawing. The effect of the moon on tides is exposed in a simple way. A series of moving arrows between the earth and the moon pictures the pull that the latter exerts on the former. The force is similar to magnetism; and this comparison is shown by replacing the moon by a magnet, showing the water rising from the earth's surface in response to the pull of the magnet. When the magnet is replaced by the moon again, the phenomenon has been perfectly explained. This attraction of the moon for the earth's waters is shown in action on opposite sides of the earth's surface. The explanation is conveyed in a title:

"The opposite side of the earth will have high tide at the same time because the earth itself is drawn towards the moon away from the water."

The reason for low tide follows inevitably. How two tides a day result from the revolution of the earth is shown in the same graphic way that high and low tides are explained. Perhaps the most interesting phase of this educational picture explains the difference between spring tides and neap tides.

In spring tides the position of the moon is directly between the sun and the earth. Consequently, the double pull exerted by them results in extremely high tides. However, when the sun and the moon are at right angles to the earth, the pull of the moon is somewhat diminished by the attraction of the sun. When the earth is in this position, with reference to the sun and the moon, we have what are known as "neap" tides.

Instruments for indicating as well as for predicting high tides are carefully explained. At the conclusion of this animated technical drawing, the subject has been quite thoroughly presented. In fact, any child is able to follow the "story" because it is constructed on sound pedagogical principles. All these animated technical drawings begin with a phenomenon that is common everyday knowledge; and by adding fact to fact and by making intelligent use of the process of analogy an entirely new fund of knowledge is built up in less than fifteen minutes.

San Francisco Goes to the Mountains

(Continued from page 704)

tically subjected to compressive stresses only." There seems to be just one reason for the steel and that is in connection with the possibility that tension may be developed by temperature changes. So, some steel goes in to cover the hazard.

It is expected that sooner or later the development of the San Francisco water supply resources will require a high dam at Lake Eleanor. The present new dam may then be made the upstream toe of a higher and bigger structure. This is in contemplation even now. So, one need not wonder at the selection of the multiple-arch type.

The solid foundation for Lake Eleanor Dam was found not at the very mouth of the lake but at a location about a mile farther down. Here the bedrock was readily put in shape for its great service. At this point a dam 250 feet high may properly be erected, when the demand for water has sufficiently increased.

Dams are often a long time in building. But this was not at all the case here. The preliminary examination of the site was made by the City Engineer on July 30, 1917. So rapidly was the foundation prepared and the making of necessary forms got under way that concrete was being poured on November 4. Haste was required in a large way because the construction power plant would want water in the dry season of 1918. But it was desirable for another reason. That is, the engineers wanted the concrete in the base of the dam to be at a substantial height before the heavy snow of the approaching winter would compel suspension. During the thawing period of the following spring a considerable amount of water would be starting and, unless subject to some control by a partial dam, would delay the pouring of concrete until late in the season. So, haste was required at the beginning in order to make possible further haste somewhat later on. Concrete was poured pretty continuously until December 22, when work was discontinued until April 22, four months later. Then the saw-mill resumed operations. Pouring began again on May 11. Six holes had been left in the incomplete structure and these passed the water during the floods. The concreting was pressed on, cement having been stored at the site in anticipation of difficulties in transportation in the early part of the season. Later on additional cement needed was hauled in from the Hetch Hetchy Railroad by a fleet of twelve auto trucks. This is a construction railway 68 miles long. It has its lower terminal at Hetch Hetchy Junction which is near Rosaco, a stop on the Sierra Railway of California. It carries materials, supplies and men off into the Sierra Nevada foothills to a point known as Damsite, near which the great Hetch Hetchy Dam will rise.

The planning of the details of a multiple-arch dam has to be carried out with the greatest care. The arches of the Lake Eleanor Dam were set at an inclination of 50 degrees with the horizontal. The central arches have their crests about 70 feet above the foundation platform. The arch barrel if cut through horizontally would disclose a circular outline on the upstream side, curved on a radius of 23 feet. This dimension, taken in connection with the span of 40 feet, yields upon calculation a central angle of 120° 50′. The most economical angle is theoretically 133½°; but deviations need to be made because of conditions. In the present case the deviation from the ideal is not quite 10 per cent. The topmost 7 feet of the arch was made vertical. However, the horizontal radius of 23 feet was not disturbed.

In a typical section of a gravity dam, the wall thickness becomes greater with the depth, so that at and near the crest it will be comparatively thin, while near the base it becomes excessively thick. This same general rule of an increasing thickness of wall as the depth increases is carried out with the arch barrels of Eleanor Dam, but in a manner so modified that a rather sharp contrast is afforded. Thus, the top 7 feet of wall is 15 inches thick. At the base of the arches, which reach down 70 feet below the crest, the thickness of wall, measured horizontally, reaches only about 4 feet. This is a very moderate increase from 1.25 feet in a change of level of 70 feet. If the thickness at or near the base be measured perpendicularly to a tangent plane, it will amount to but 1 inch in excess of 3 feet. The reader will, in respect to economy, now get a view that is perhaps better than the one obtained earlier.

It will be gathered perhaps from the foregoing that the carpenter work on the forms was not of the simplest. They were carried up in sections of about 10 feet in height. These were rested on trestlework. As the job progressed the trestle had to be carried up higher and higher. The concrete was all poured in a period really amounting to less than a year, if one disregards the four months' suspension of work in the winter. And the dam was in actual use before it was quite completed, supplying water for power-house purposes.

After completion of the masonry work, the surface was given a coating of cement grout ¾ inch thick. The structure not only serves as a dam but it provides a 12-foot roadway along its crest.

The whole dam, including the spillway and gravity sections, is 1,260 feet long and contains 11,640 cubic yards of concrete. This volume is to be regarded as very much less than a solid gravity structure would have required. The reinforcement amounted, on the average, to about 22.5 pounds of steel per cubic yard of concrete. For the withdrawal of storage water, two 24-inch sluice valves are provided. The present flow line of Lake Eleanor Reservoir is 4,660 feet above the sea. The capacity for storage is some 8,200,000,000 gallons, not a large part of the watershed. With the future flow line at elevation 4,770, the capacity will be around six times as great as at present. It will even then be much smaller than the great Hetch Hetchy Reservoir with its 112,000,000,000 gallons, but will nevertheless be comparable with it. The earlier function of Lake Eleanor Reservoir will be promotion of the general work by supplying power water and participation in a minor way in furnishing San Francisco with its necessary city water.

Measuring Deflection with Interference Bands

(Continued from page 705)

shown in the other picture, and a similar series of interference bands is seen through the hole in the channel iron. When the bar is bent downward the distance between the glass and the mirror increases and the interference bands are seen to move, say, to the right. When the bar is bent upward the distance decreases and the bands are seen to move in the opposite direction or to the left.

A slight downward pressure exerted in the middle of the bar with the fingers thus causes the interference bands to move to the right, and also a slight upward pressure exerted under the bar at the middle causes the bands to move to the left. It is evident therefore that the bar bends the instant that the slightest force is applied.

From the teachings of mechanics of materials we know that a pressure of one pound applied in the middle of a 4-inch-diameter steel bar having end supports 28 inches apart would cause a deflection or bending of approximately 1/825,000 inch or a little more than one millionth of an inch. The application of a pressure of from 5 to 10 pounds with the finger requires no special effort, and thus with an ordinary pressure of about 8 pounds the bands will move just about the distance between them or about ⅛ of an inch. Approximately a movement of the bands of one-tenth of the distance between them as results from the application of about one pound pressure, is easily discernible. Thus it is possible to measure the deflection or bending in millionths of an inch.

A column, post or stud used in building supports is simply a beam on which pressure is applied at both ends. This pressure when not exactly applied in the center line of the column results in the buckling of the support.

The demonstration showing the buckling of the bar with a pressure of the fingers is even more striking than that of bending the bar by a direct downward

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pressure; as it serves to prove even more convincingly the sensitiveness of light-wave measurement. Thus when a pressure is applied with the fingers at either end of the bar at the top the bands are seen to move, not quite so much, but in the same direction as when a downward pressure was exerted directly in the middle of the bar; and it is known therefore that the bar has been buckled downward. Then upon applying a similar pressure at either end at the bottom of the bar the bands move in the opposite direction or in other words the bar is buckled upward.

An Electrode That Bakes Itself

(*Continued from page 705*)

as is used in ordinary carbon electrodes which are to be baked. The ingredients consist of coke, anthracite, tar and pitch, all finely ground and mixed together in the usual proportions at a temperature of about 80 degrees Centigrade. In order to obtain a higher conductivity in the baked carbon, the anthracite used is preferably semi-graphitized. This is done by heating it in an electric furnace of the usual type for this purpose. The mixing with pitch and tar is done in the usual manner in a heat-mixing machine. If the mixture is allowed to cool, it must be reheated before it can be stamped into the electrode.

The Soderberg electrodes will certainly increase the regularity of running of electric furnaces to which they can be adapted, both because of their absolute continuity in respect to absence of joints and because of the uniform quality of the raw materials going into the electrodes, there being no such variation in the quality of these materials as is almost unavoidable when separate previously-baked electrodes purchased on the market are inserted one after the other. They will, further, obviate the shutdowns which are necessary when built-up, previously-baked electrodes are being changed or renewed, and this continuity of running is undoubtedly of great technical and still greater economic advantage.

Baked carbon taken from the furnace end of a Soderberg electrode is dense, hard, and of the ordinary quality of previously baked electrodes. It shows in this respect no difference from ordinary carbon electrodes.

The Heavens in July, 1920

(*Continued from page 706*)

Venus is in conjunction with the sun on the 3rd, and is behind him, so that she seems to move slowly, and is invisible throughout the month.

Mars is in Virgo, and remains in sight till about midnight, standard time (as all other hours mentioned). He moves gradually eastward among the stars and is no longer as near the bright star Spica as he was in June, but about four degrees east of it at the beginning of the month, and 16 degrees at its close. At the same time he is rapidly receding from the earth and growing fainter, so that he is only about three times as bright as Spica, as against eight times in May.

Jupiter is an evening star, too, in Leo, setting about an hour after Jupiter.

Uranus is in Aquarius, and comes to the meridian at about 3 A. M. in the middle of the month. Neptune is in Cancer, and is too near the sun to be seen.

The moon is full at 4 A. M. on July 1st, in her last quarter at midnight on the 8th, new at 3 P. M. on the 15th, in her first quarter at 3 P. M. on the 22nd, and full again at 6 P. M. on the 30th. She is nearest us on the 14th and farthest away on the 27th. While making her circuit of the sky she passes by Uranus on the 6th, Venus on the 15th, Mercury and Neptune on the 16th, Jupiter on the 17th, Saturn on the 18th, and Mars on the 23rd. The conjunction with Mars is close, and an occultation is visible, but only in Siberia, as that side of the earth is turned toward the planet.

PRINCETON UNIVERSITY OBSERVATORY.
June 14, 1920.

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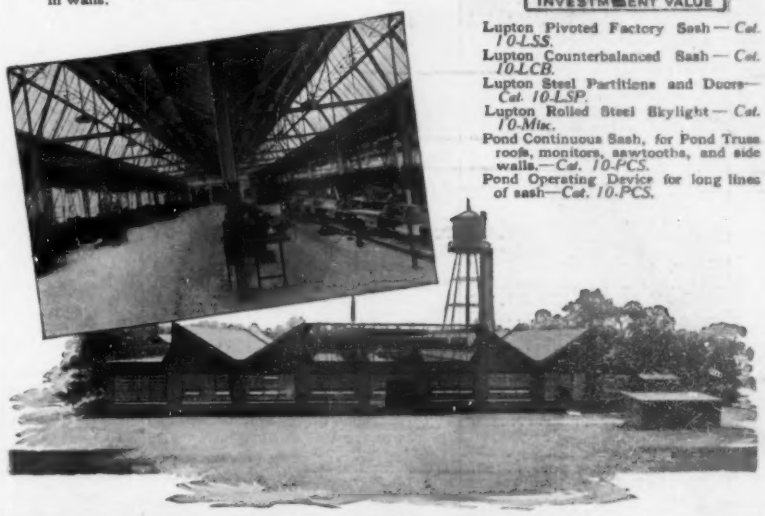

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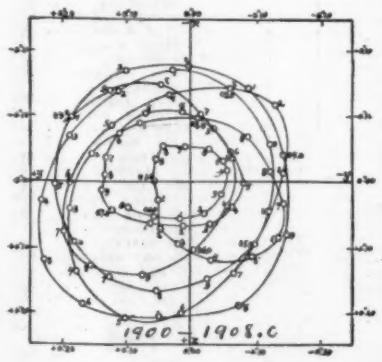
Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to correspondents are printed from time to time and will be mailed on request.

(14323). R. G. O. asks: Would you be so kind as to answer the following two questions: Is the axis of the earth at the magnetic poles, exactly? Does the axis of the earth ever move the least particle with the seasons? A. The axis of the earth is not at the magnetic poles, nor does the axis move from its fixed direction in space. The geographic poles of the earth are the points where the axis of the earth passes out from the earth into space. The magnetic poles are the points where a balanced magnetic needle capable of swinging up and down in a vertical direction would stand vertically, straight up and down. The north magnetic pole was found in 1831 by Sir J. C. Ross in latitude 70 deg. 5 min. north, longitude 96 deg. 46 min. west. The south magnetic pole was found by Shackelton's party in 1909 in latitude 72 deg. 25 min. south, and longitude 155 deg. 16 min. east. Each of these positions are 1,000 miles or more from the poles of the earth. Nor are the magnetic poles at rest in the earth. The north magnetic pole was found by Amundsen in 1903 to have moved quite a distance from the position where it was in 1831, and the south pole in 1909 found to have moved about 25 miles to the north and 100 miles to the west of the place where it was located by Capt. Scott's party some six years before. Then again, the earth's geographic poles do not remain exactly in the same place in the earth. This does not mean that the direction of the earth's axis changes in space but that the earth itself shifts its position with reference to its axis slightly. This causes a change in the latitude of places on the earth. The poles of the earth are not fixed points on its surface, and if the poles change the equator must also change. This is often called the Wandering of the Terrestrial Poles. This motion is not very wide. A circle 60 feet in diameter would contain all the positions of the north pole since this motion was discovered about 1885. A change of 30 feet corresponds to about three-tenths of a second of arc, and this could not be detected excepting by the most refined measurements. The accompanying chart is from Popular Astronomy and gives the motion of the pole for eight years by tenths of a year from 1900 to 1908:



Upon the accompanying chart the position of the north pole of the earth, relative to its mean position, as determined by Prof. Albrecht from the combination of the results from the sixth stations, is plotted for the eight years 1899.9 to 1908.0. The smoothness of the curve shows the remarkable accuracy of the observations as well as the systematic but complicated character of this minute movement of the pole.

(14324) P. J. B. says: I would like to find out if fraternities should have three letters (Greek fraternities) upon their pin or is it just the same to have two letters. Also should the chapter letter be placed upon the pin or is it supposed to be a separate pin? Could you tell me just what should be written on a certificate of membership? There are also some other subjects that I would like to ask. I would like to know what the latest theory is concerning sun-spots, volcanoes. Also I would like to know about this Moon-Pool or Black Pool, or Black Moon Pool that is supposed to have been discovered down in Africa about six months ago. From what I have heard it has been recently discovered, and is supposed to be constantly seething and foaming. It is said that at night they hear sounds of people yelling for help and yelling for release from under the waters. The waters are said to be black in color. The seething only goes on at night. Yet, I don't believe this, which seems only a fairy tale, but to be sure I have written this letter. I heard of it through a friend, who says he saw it in the SCIENTIFIC AMERICAN. Well, I hope to have an early reply in the SCIENTIFIC AMERICAN'S correspondence column, or by writing an answer. A. The Greek letters which are commonly used as the name of a college fraternity, or sorority in women's colleges, are usually the initials of the motto of the society. If the motto has three words there are three letters; if two, there will be two letters. It is simply a matter of a name. There is no rule about it any more than there is for the name of a person. If a person has a middle name he will have three initials; if he has not a middle name he will have two initials. The chapter letter may or may not be on the pin just as the organization rules require. We cannot say what should be written on a certificate of membership. That is for the order to determine, each society for itself. As to the "Moon Pool" we have no information. There are many hot springs and mud pools in various parts of the earth, notably in New Zealand and the Yellowstone Park, from which the escape of steam produces sounds of a sort that ignorant and credulous persons can imagine voices and groans such as you describe. We have no information as to this particular pool, but it must be a fairy tale to say that people can exist under water or mud as you describe in your letter. Sun spots are great whirling storms on the sun producing cavities in the matter of the sun's surface. You will find a full treatment on the subject in The Sun, by Abbott. The book is very interesting. Volcanoes are places where there are great masses of melted rock under the surface of the earth and when water gets into them the steam is under great pressure so that it ejects the melted rock out of the crater and often high in the air. You will find these described in Tarr's College Physiography. You will find both these books very valuable additions to your library. We will send the Sun for $3.70 and the Physiography for $3.90.

(14325) A. E. S. asks: Would you be kind enough to let me know if you have had any articles in your publication on novelties in glass making, and, if so, could I get a copy of the issue? Of course I am familiar with the glass-flower collection at Harvard University, and glass wool used by chemists; but I understand attempts have been made to *use glass for men's ties.* I would like to know if in making the glass wool anything is used but glass? A. Cloth has been woven with silk warp and a filling of spun glass. We have never seen a necktie made of this cloth. It is possible that such a tie has been made and worn, but we should beg to be excused from being the model for exhibiting such a curiosity, since every fiber of glass is a sharp pointed needle with which to pierce the skin, and very troublesome sores might result from such a puncture. The writer has a piece of this glass cloth and has often been pricked in exhibiting it. Spun glass is made by drawing melted glass into a fine fiber.

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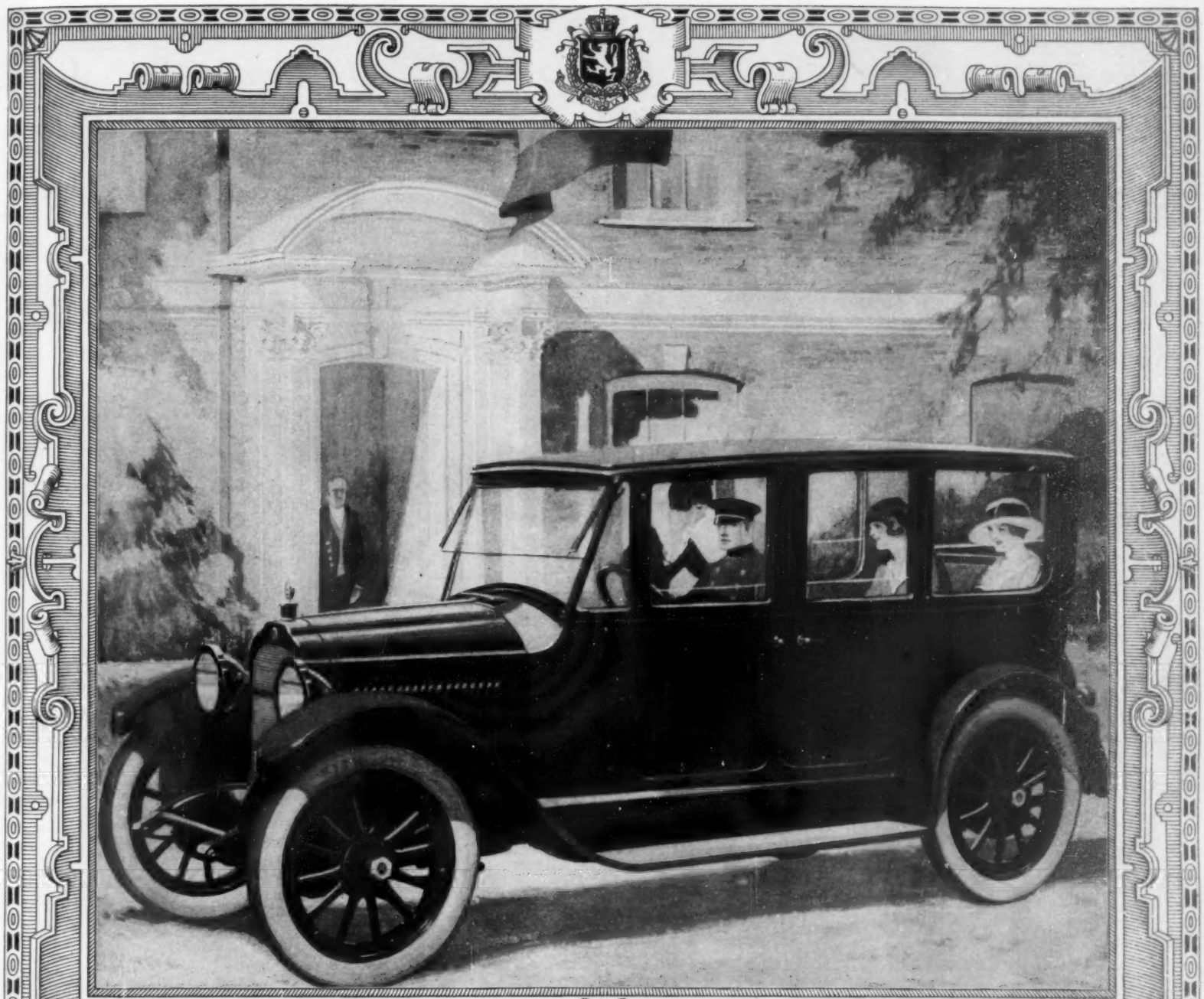


Entrance Belgian Embassy, Washington, D. C.

WILLYS-KNIGHT

OWNERS who have driven this car for long periods, over great distances, and under all conditions of travel, find that its power is increased and it runs even more quietly after miles of use. They declare the *only* change in the Willys-Knight Sleeve-Valve motor is *improvement with use.*

They find a source of steadily growing satisfaction in its daily consistency of performance, and the realization that its sleeve-valves need no adjustment.

From this accumulated experience of owners, *you* can judge what the Willys-Knight car will mean to you.

Willys-Knight Booklet on Request

WILLYS-OVERLAND, INC., TOLEDO, OHIO
Willys-Overland Limited, Toronto, Canada

Willys Knight
SLEEVE-VALVE MOTOR IMPROVES WITH USE

Part of the 120 horse equipment, formerly used by the DuFur Orchard Company. Three Federal tractors are now doing the work formerly performed by all of these horses.

Friends of Men—

Out in the fruit belt of Central Oregon, last season, these 120 brawny, sturdy, loyal "friends of man" passed into discard.

Their work, that of transporting apples from the 4000 acre orchard of the DuFur Orchard Company to their shipping sheds, is now being done more satisfactorily, more expeditiously and more economically by three Federal tractors with a complementary equipment of nine trailers.

So the day of horse-drawn equipment in agriculture has passed —regretted by some, as the passing of old friends must, but welcomed, too, in the light of the greater accomplishments of power farming equipment.

For those qualities which have so endeared the horse to the American farmer—sturdiness, loyalty, strength and dependability, are found today, in far greater measure, in his Federals. Ten years of honest, intelligent effort in truck building have made Federals so.

For after all, the best friends of man are those friends which serve him best.

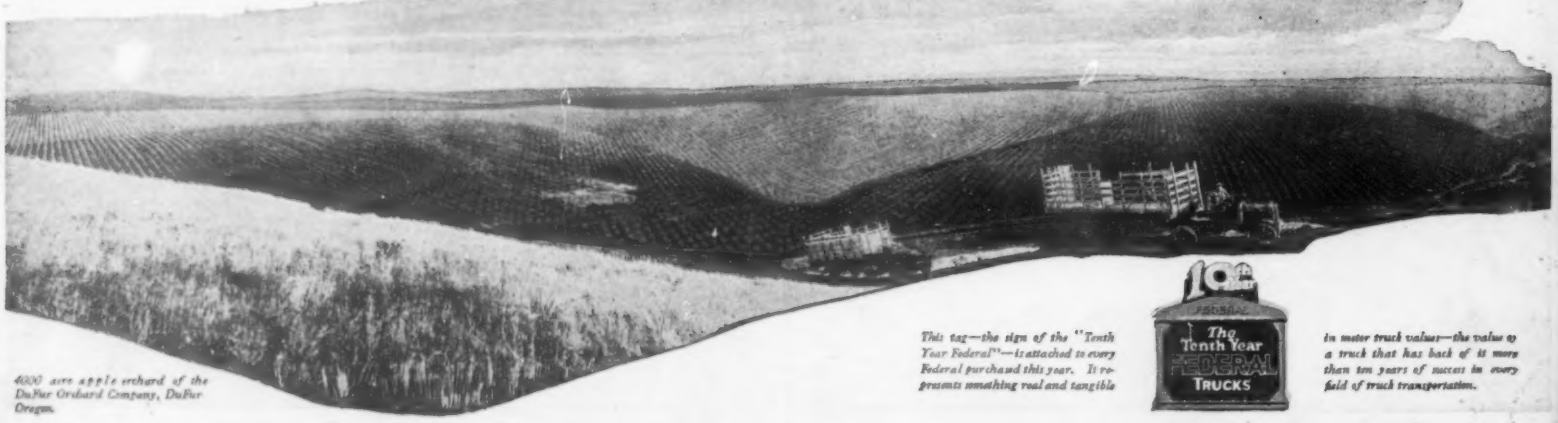
Yesterday, his horse, today and tomorrow, his Federal.

FEDERAL MOTOR TRUCK COMPANY, DETROIT, MICH.

These three Federal Tractors haul eight, seven and one half ton loads each day for a distance of from four to six miles —or 240 ton-miles every twelve hours.

FEDERAL

One to Five Ton Capacities



4000 acre apple orchard of the DuFur Orchard Company, DuFur Oregon.

This tag—the sign of the "Tenth Year Federal"—is attached to every Federal purchased this year. It represents something real and tangible in motor truck values—the value of a truck that has back of it more than ten years of success in every field of truck transportation.